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ISO/IS 10303-227

Product data representation and exchange — Application protocol: Plant spatial configuration

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ABSTRACT: This document specifies the Application Protocol for the exchange of the spatial configuration of plant systems with a central emphasis on piping systems. This part specifies the information required to construct a piping system, including the shape, material, and arrangements of the components of the system. It also specifies requirements for the physical aspects of other plant systems (e.g., heating, ventilation and air-conditioning) needed to design and layout the piping system.

KEYWORDS: application protocol, heating, ventilation, and air conditioning (HVAC), piping system, process plant, spatial configuration

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Foreword

ISO (International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 10303-227 was prepared by Technical Committee ISO/TC 184, *Industrial automation systems and integration*, Subcommittee SC4, *Industrial data*.

This second edition of ISO 10303-227 cancels and replaces the first edition (ISO 10303-227:2000), of which it constitutes a technical revision.

This International Standard is organized as a series of parts, each published separately. The structure of this international standard is described in ISO 10303-1.

Each part of this International Standard is a member of one of the following series: description methods, implementation methods, conformance testing methodology and framework, integrated generic resources, integrated application resources, application protocols, abstract test suites, application interpreted constructs, and application modules. This part is a member of the application protocols series.

A complete list of parts of ISO 10303 is available from the Internet:

<http://www.nist.gov/sc4/editing/step/titles/>

Should further parts of ISO 10303 be published, they will follow the same numbering pattern.

Annexes A, B, C, D, and E form a normative part of this part of ISO 10303. Annexes F, G, H, J, K, L, and M are for information only.

Introduction

ISO 10303 is an International Standard for the computer-interpretable representation of product information and for the exchange of product data. The objective is to provide a neutral mechanism capable of describing products throughout their life cycle. This mechanism is suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases, and as a basis for archiving.

This part of ISO 10303 is a member of the application protocol series. This part of ISO 10303 specifies an application protocol (AP) for the exchange of the spatial configuration information of process plants, plant systems and ship systems. This information includes the shape, spatial arrangement and connection characteristics of piping, HVAC (heating, ventilation and air-conditioning) and cableway system components as well as the shape and spatial arrangement characteristics of other related plant systems (e.g., instrumentation and controls, and structural systems). Users of this standard should understand the basic principles and concepts of plant design, and piping, HVAC and cableway system design.

This AP specifies requirements for the exchange of information required for the design, analysis, fabrication and installation of piping components and piping systems and information on the inspection of fabricated piping. This AP specifies requirements for the exchange of information required for the design, analysis and installation of HVAC components and HVAC systems. This AP specifies requirements for the exchange of information required for the design and installation of cableway components and cableway systems. This AP also specifies requirements for the exchange of functional characteristics for HVAC and piping components and systems. The

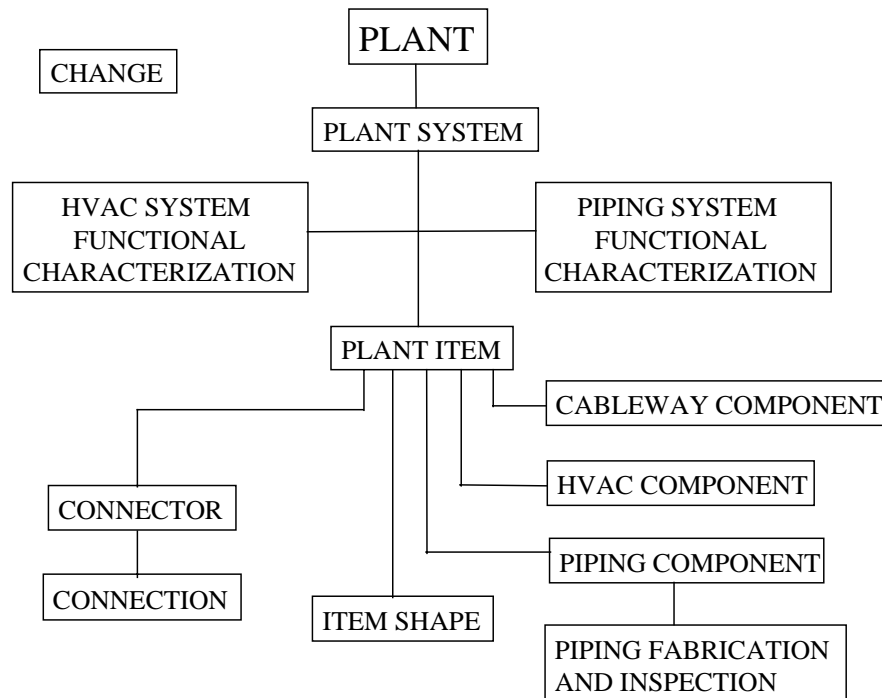


Figure 1 - Data planning model

design information for a piping system may specify a pump capable of maintaining a pressure and flow rate. The design may also specify the shape limitations or requirements and the location of the pump in the system, but the design will not include sufficient information for the fabrication of the pump.

Figure 1 contains a data planning model that provides a high level description of the requirements for this application protocol, as well as the relationships between the basic data concepts. The data planning model illustrates that a plant consists of plant systems, plant systems consist of plant items and plant items may be connected to one another using connectors on the plant item. The shape and spatial arrangement of plant items are represented by the item shape. The shape representation may use constructive solid geometry (CSG), solid boundary representation (Brep) geometry, wireframe geometry, or combinations of these. The plant item shape may be represented at various levels of abstraction, from an encompassing envelope to a detailed design description. The data planning model further illustrates that the concept of change is a requirement for this application protocol. Change is applicable to each individual plant item, the relationships between plant items, and to groupings of plant items. It applies to all the concepts noted on the data planning model.

NOTE This part of ISO 10303 may be used in conjunction with ISO 13584 [13] to identify catalogue items and classifications.

This application protocol defines the context, scope, and information requirements for the exchange of design and layout information for a process plant, plant systems, ship systems, system components and equipment between different agents over the life cycle of the facility and specifies the integrated resources necessary to satisfy these requirements. The reasons for exchanging this information include:

- exchange of requirements from an owner to an engineering firm;
- exchange of cableway, HVAC, piping and equipment designs between a design engineer and a system engineer;
- exchange of cableway, HVAC, piping and equipment designs between a design engineer and a fabricator;
- exchange of changes to cableway, HVAC, piping and equipment designs between a design engineer and a system engineer or a fabricator;
- exchange of piping fabrication information, fabricated piping inspection results and installation information between engineering, fabrication and construction firms;
- integration of designs created by different engineers;
- detection of physical interferences of systems and components with components of other systems;
- exchange of cableway, HVAC and piping installation information between engineering and construction firms and with owner organizations;

— exchange of as-built facility and system configurations among owners, engineering firms and construction firms.

Application protocols provide the basis for developing implementations of ISO 10303 and abstract test suites for the conformance testing of AP implementations.

Clause 1 defines the scope of the application protocol and summarizes the functionality and data covered by the AP. Clause 3 lists the words defined in this part of ISO 10303 and gives pointers to words defined elsewhere. An application activity model that is the basis for the definition of the scope is provided in annex F. The information requirements of the application are specified in clause 4 using terminology appropriate to the application. A graphical representation of the information requirements, referred to as the application reference model, is given in annex G.

Resource constructs are interpreted to meet the information requirements. This interpretation produces the application interpreted model (AIM). This interpretation, given in 5.1, shows the correspondence between the information requirements and the AIM. The short listing of the AIM specifies the interface to the integrated resources and is given in 5.2. Note that the definitions and EXPRESS provided in the integrated resources for constructs used in the AIM may include select list items and subtypes which are not imported into the AIM. The expanded listing given in annex A contains the complete EXPRESS for the AIM without annotation. A graphical representation of the AIM is given in annex H. Additional requirements for specific implementation methods are given in annex C.

Industrial automation systems and integration — Product data representation and exchange — Part 227: Application protocol — Plant spatial configuration

1 Scope

This part of ISO 10303 specifies the use of the integrated resources necessary for the scope and information requirements for the exchange of spatial configuration information of process plants, plant systems and ship systems. The spatial configuration information focuses on the shape and spatial arrangement of the components of the systems. The spatial configuration information principally supports the engineering, fabrication and installation life-cycle phases, but may be useful in the downstream life-cycle phases of operations and maintenance. This part accommodates the disciplines of plant design, system design, fabrication, inspection, installation and construction.

NOTE 1 The application activity model in annex F provides a graphical representation of the processes and information flows that are the basis for the definition of the scope of this part of ISO 10303.

NOTE 2 Figure 2 illustrates the basic life-cycle stages of a process plant. Plant life-cycle phases for which AP 227 is useful are enclosed in the rounded rectangles labeled “AP 227 ed2”.

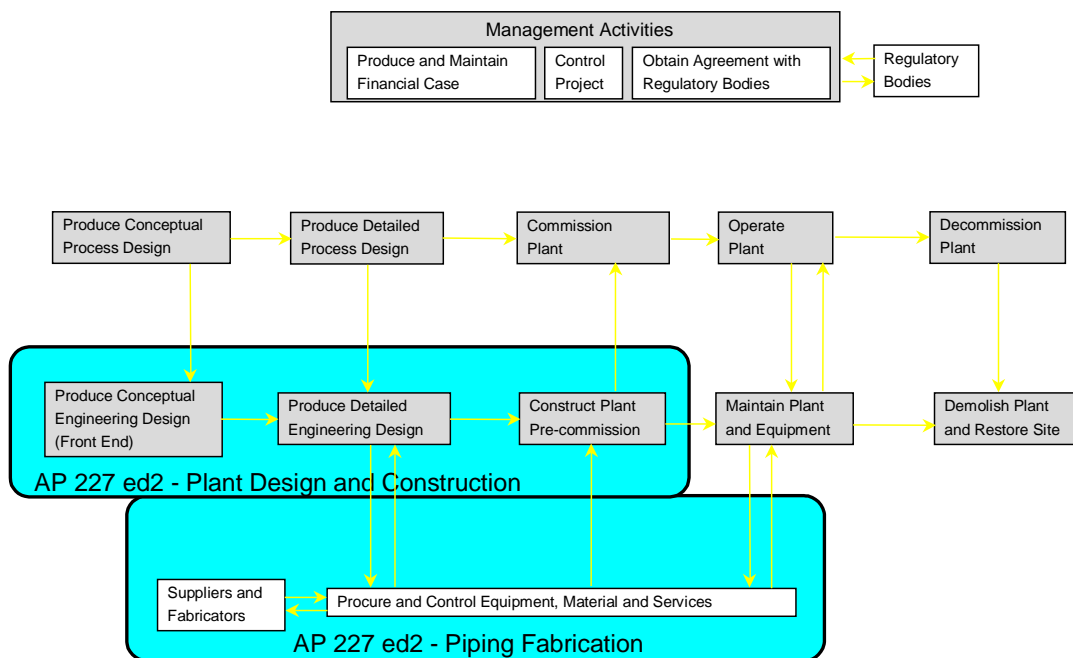


Figure 2 - Process plant life cycle activity coverage

The following are within the scope of this part of ISO 10303:

- the shape and spatial arrangement of items in systems within a process plant or ship;
- explicit representation of the 3D shape of systems and components;
- explicit representation of the 3D external shape of system components and equipment.
The representation may include envelope, outline and detailed representations as well as a parametric representation of the external shape.
- the functional configuration of HVAC and piping systems and the relationship of the functional configurations to the physical system design;
- information required for the design, analysis, fabrication and installation of piping components and piping systems;
- information on the inspection of fabricated piping;

NOTE 3 The functional configuration entails connectivity, sequencing, component size, and schedule, and may include other information, such as equipment tag numbers and requirements to perform consistency checks between the functional and physical representations of the design.

- basic engineering data as needed for spatial layout and configuration of systems;
- references to functional requirements of plant systems, such as stream data and operational characteristics;
- references to or designation of functional characteristics of components and connected equipment as required for system design;
- the identification, shape, location, and orientation of reserved areas, volumes, and space-occupying elements of a plant;
- references to specifications, standards, guidelines, or regulations for the systems, components, or connected equipment that may specify physical characteristics or performance characteristics of the system or component;

EXAMPLE 1 Physical characteristics include material and welding requirements.

EXAMPLE 2 References to standards include ISO 10303-221 [3] and ISO 13584 [13].

- the identification of catalogue information associated with a component;
- the identification of catalogues that contain component definitions;
- status of components and connected equipment and of their spatial arrangement;

NOTE Status labels are used by project management to monitor and control the execution of the project. Labels such as "preliminary", "in-work", and "released for fabrication" are used

to designate the degree of completeness or suitability for further action of the design or layout that the label is applied to.

- connections and connection requirements for cableway, HVAC and piping components and equipment;
- definition of components in sufficient detail to support the acquisition of the components;
- change request approval, notification, and verification, tracking of differences between versions of system information, and tracking of changes to plant items and attributes of plant items;

NOTE Only the specific change information described in this part of ISO 10303 is in scope. The change process itself is not in scope.

- specification of the chemical composition of the streams carried by the piping and HVAC systems in sufficient detail to evaluate the suitability of components for the desired process;
- data exchange;
- external reference to classification systems;
- external reference to standard parts;
- external reference to representations of standard parts.

The following are outside the scope of this part of ISO 10303:

- schematic representations;

EXAMPLE Schematic representations include P&IDs and process flow diagrams (PFDs).

- the contents of specifications, standards, guidelines, or regulations;
- preparation of piping specifications;
- logistics and materials management;
- specification of the chemical composition of the streams carried by the piping system in sufficient detail for process flow design;
- process design and conceptual engineering;

EXAMPLE Process design includes activities such as process material and heat balances, process flow diagram development, and determination of equipment sizes.

- testing, commissioning, handover, maintenance, and disposal of a plant;

- plant operating procedures;
- commercial aspects of procurement and contracting;

EXAMPLE Commercial aspects include pricing, terms and conditions, and payment schedules.

- information necessary to manage the evolution and growth of data sets through the life-cycle of a product or project other than indications of changes and approvals;
- history data;
- internal design and maintenance of equipment.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/IEC 8824-1:1995, *Information technology — Open systems interconnection — Abstract syntax notation one (ASN.1): Specification of basic notation*.

ISO 10303-1:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 1: Overview and fundamental principles*.

ISO 10303-11:1994/Cor 1:1999, *Industrial automation systems and integration — Product data representation and exchange — Part 11: Description methods: The EXPRESS language reference manual*.

ISO 10303-21:1994/Cor 1:1996, *Industrial automation systems and integration — Product data representation and exchange — Part 21: Implementation methods: Clear text encoding of the exchange structure*.

ISO 10303-31:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 31: Conformance testing methodology and framework: General concepts*.

ISO 10303-41:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 41: Integrated generic resources: Fundamental of product description and support*.

ISO 10303-42:2000, *Industrial automation systems and integration — Product data representation and exchange — Part 42: Integrated generic resources: Geometric and topological representation*.

ISO 10303-43:2000, *Industrial automation systems and integration — Product data representation and exchange — Part 43: Integrated generic resources: Representation structures*.

ISO 10303-44:2000, *Industrial automation systems and integration — Product data representation and exchange — Part 44: Integrated generic resources: Product structure configuration*.

ISO 10303-45:1998, *Industrial automation systems and integration — Product data representation and exchange — Part 45: Integrated generic resources: Materials*.

ISO 10303-46:1994, *Industrial automation systems and integration — Product data representation and exchange — Part 46: Integrated generic resources: Visual presentation*.

ISO 10303-47:1997, *Industrial automation systems and integration — Product data representation and exchange — Part 47: Integrated generic resources: Shape variation*.

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ISO 13584-24:1995, *Industrial automation systems and integration — Parts library — Part 24: Logical model of supplier library.*

ISO 13584-42:1995, *Industrial automation systems and integration — Parts library — Part 42: Methodology for structuring part families.*

3 Terms, definitions, and abbreviations

3.1 Terms defined in ISO 10303-1

This part of ISO 10303 makes use of the following terms defined in ISO 10303-1:

- abstract test suite (ATS);
- application;
- application activity model (AAM);
- application interpreted model (AIM);
- application protocol (AP);
- application reference model (ARM);
- conformance class;
- implementation method;
- integrated resource;
- product;
- product data;
- protocol information and conformance statement (PICS);
- unit of functionality (UoF).

3.2 Terms defined in ISO 10303-31

This part of ISO 10303 makes use of the following terms defined in ISO 10303-31:

- conformance testing;
- implementation under test (IUT).

3.3 Other definitions

For the purposes of this part of ISO 10303, the following definitions apply:

3.3.1 actual

descriptive adjective that, when applied to an item, indicates that the item exists at some time in the real world. An actual plant item (see **3.3.31**) has properties that can be measured or observed

NOTE 1 The terms actual, planned (see **3.3.31**), and required (see **3.3.41**) loosely reflect life-cycle stages of an item.

NOTE 2 Within the scope of this part of ISO 10303, being actual can be specified for an item that is:

- a plant item;
- an association between plant items such as a connection;
- an activity or an association between a plant item and an activity;
- a possession of a property by a plant item or activity.

NOTE 3 An item cannot be both actual and planned (see **3.3.31**). An actual item can be the realization of an planned item.

3.3.2 assembly

a set of items that have a relationship to each other apart from being members of the same set

NOTE Within the scope of this part of ISO 10303, an assembly can be items that are plant items (see **3.3.32**).

3.3.3 basic engineering data

parameters and descriptions that specify design (see **3.3.11**) characteristics and boundaries for the plant item (see **3.3.32**) that are required to support piping system (see **3.3.30**) design

EXAMPLE Piping system design parameters and descriptions include design temperature, design pressure, design codes, and weights.

3.3.4 branch

a portion of a piping system (see **3.3.30**) that diverges or divides from the main flow path

NOTE A branch may have a different identifier from that of the main flow path.

3.3.5 catalogue

a collection (see **3.3.6**) of items or an electronic or paper document that contains information about a collection of items

NOTE Within the scope of this part of ISO 10303, a catalogue can be a collection of typical or reference plant items (see **3.3.32**), that the definition of a specific occurrence of a plant item in the design (see **3.3.11**) of a process plant (see **3.3.37**) can be selected from.

3.3.6 collection

a set of things that do not have any relationship to each other apart from being members of the same set

NOTE Within the scope of this part of ISO 10303, a collection can be items that are plant items (see **3.3.32**).

3.3.7 component

an item that may be part of another item

NOTE 1 Within the scope of this part of ISO 10303, an item that is a component can be part of a functional (see 3.3.13) or physical (see 3.3.24) plant item (see 3.3.32) or part of a process material (see 3.3.36) that is a mixture.

NOTE 2 A component can itself have components.

3.3.8 connection

an association between two items that enables the flow of process material (see 3.3.36), energy, mechanical loads, or signals between them or constrains their relative positions

NOTE 1 Within the scope of this part of ISO 10303, a connection can be between either functional (see 3.3.13) or physical (see 3.3.24) plant items (see 3.3.32).

NOTE 2 A connection can be the result of a physical (see 3.3.24) joining.

NOTE 3 A functional connection can exist between two plant items (see 3.3.32) without a physical (see 3.3.24) joining of the plant items.

3.3.9 connector

a physical (see 3.3.24) or functional (see 3.3.13) property of a plant item (see 3.3.32) that links it to another plant item, or to a compatible connector on another plant item. This linkage enables the flow of energy, mechanical loads, process material (see 3.3.36), or signals through the connected plant items

3.3.10 construction material

the substance or substances that a physical (see 3.3.24) plant item (see 3.3.32) is made from

3.3.11 design

a representation (see 3.3.40) of a process plant (see 3.3.37), portion of a process plant, or plant - item (see 3.3.32), that is created for a specific purpose and uses a consistent syntax and symbology

NOTE A PFD is a design that represents the flow and reaction of process materials (see 3.3.36). A P&ID is a design that represents the logical functionality of a piping system (see 3.3.30). A three-dimensional geometric model is a design that represents the physical (see 3.3.24) shape and arrangement of the components (see 3.3.7) of a process plant (see 3.3.37) or plant system (see 3.3.33).

3.3.12 equipment

a plant item (see 3.3.32) that carries out an operation and that is treated as a single item for the purpose of design (see 3.3.11), acquisition, or operation

NOTE An equipment has both physical (see 3.3.24) and functional (see 3.3.13) aspects.

3.3.13 functional

descriptive adjective that, when applied to an item, refers to the actions, activities, or capabilities, that the item provides or may provide to fulfill a purpose

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NOTE In the process plant industry, a plant item (see **3.3.32**) that provides functional capability in a process plant (see **3.3.37**) is typically denoted by a tag number.

3.3.14 functional characteristics

nomenclature, codes, and named values that describe or specify the performance or behaviour of a plant item (see **3.3.32**)

EXAMPLE Functional characteristics include flow rates, operating pressure, and maximum temperature.

3.3.15 functional requirements

nomenclature, codes, and named values that describe or specify the performance or behaviour to be met by a plant item (see **3.3.32**)

3.3.16 instrument

an individually identifiable plant item (see **3.3.32**) or combination of plant items, that is part of a system that monitors or controls a process plant (see **3.3.37**)

EXAMPLE Instruments include items such as control valves, sensors, and gauges.

3.3.17 insulation

a quantity of matter or space that provides resistance to the flow of heat, electricity, sound, or mechanical vibration

3.3.18 line

a logical component (see **3.3.7**) of a piping system (see **3.3.30**) that is composed of a collection (see **3.3.6**) of line segments (see **3.3.19**)

NOTE Further explanation of lines is provided in K.7.

3.3.19 line segment

an element of a line (see **3.3.18**)

NOTE Further explanation of line segments is provided in K.7.

3.3.20 line segment termination

one of two logical end-points of a line segment (see **3.3.19**)

NOTE Lines (see **3.3.18**) are composed of line segments (see **3.3.19**). Line segments are connected through line segment terminations.

3.3.21 line segment termination connection

a logical linkage between two line segments (see **3.3.19**) or between a line segment and a plant item (see **3.3.32**)

3.3.22 material

a quantity of matter

3.3.23 material stream

a flow of process material (see **3.3.36**) past a defined point along a path

3.3.24 physical

descriptive adjective that, when applied to an item, refers to a set of characteristics, properties, or traits of the item

EXAMPLE Characteristics include weight, size, and location and orientation of the item.

NOTE In the process plant industry, a physical object that is, or may be, installed as a plant item (see **3.3.32**), and can be identified by a serial number.

3.3.25 pipe

a plant item (see **3.3.32**) that is hollow and approximately cylindrical, that may have a constant cross-section along its extent, and that conveys fluid, vapour, or particulate material (see **3.3.22**)

NOTE Heating, ventilation, and air conditioning (HVAC) duct that has a rectangular cross section is not a pipe.

3.3.26 pipe fitting

a plant item (see **3.3.32**) that is used, or is intended to be used, to join or terminate pipes (see **3.3.25**) or other items in a piping system (see **3.3.30**) or equipment (see **3.3.12**) connectors (see **3.3.9**), or to provide changes of pipe direction or branching within a piping system

3.3.27 piping and instrumentation diagram

a piping and instrumentation diagram schematic representation (see **3.3.40**) that consists, as a minimum, of the functional (see **3.3.13**) connection (see **3.3.8**) and assembly (see **3.3.2**) of plant items (see **3.3.32**), and the identification of principal plant items

NOTE The piping and instrumentation diagram can also present the functional (see **3.3.13**) and physical (see **3.3.24**) aspects of plant items (see **3.3.32**).

3.3.28 piping class

a functional (see **3.3.13**) performance envelope defined by a set or range of common physical (see **3.3.24**) properties, and an identification of the pipes (see **3.3.25**), pipe fittings (see **3.3.26**), and valves that have these properties

EXAMPLE 1 Piping classes include stainless steel, cast iron, and carbon steel.

EXAMPLE 2 Physical properties of a piping class include diameter, pressure, and temperature.

3.3.29 piping specification

a definition of various aspects of a piping system (see **3.3.30**). It is also used to refer to a document or electronic file that contains such a definition

NOTE Piping system (see **3.3.30**) aspects that may be included in a piping specification include design (see **3.3.11**) pressures and temperatures, piping construction materials (see **3.3.10**), pipe wall thicknesses or schedules, types of fittings to be used, types of valves and flanges, valve and flange pressure rating requirements, and fabrication, examination,

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testing, inspection, cleaning, and installation requirements, including the requirements for seismic installations, where applicable.

3.3.30 piping system

a plant system (see **3.3.33**) that performs a transport function, and that is composed primarily of pipes (see **3.3.25**), pipe fittings (see **3.3.26**), and valves subject to the same set or sets of design (see **3.3.11**) conditions

3.3.31 planned

descriptive adjective that, when applied to an item, indicates that an item that has been designed or predicted

NOTE 1 The terms actual (see **3.3.1**), planned (see **3.3.31**), and required (see **3.3.41**) loosely reflect life-cycle stages of an item.

NOTE 2 Within the scope of this part of ISO 10303, being planned can be specified for an item that is:

- a plant item (see **3.3.32**);
- an association between plant items such as a connection (see **3.3.8**);
- an activity or an association between a plant item and an activity;
- a possession of a property by a plant item or activity.

NOTE 3 An item cannot be both actual (see **3.3.1**) and planned. An actual item can be the realization of a planned item.

3.3.32 plant item

a physical (see **3.3.24**) object or volume of space that is, or is intended to be, a part of a process plant (see **3.3.37**). A plant item can be an assembly (see **3.3.2**) of other plant items. A plant item has both physical (see **3.3.24**) and functional (see **3.3.13**) aspects

NOTE If a plant item is a volume of space, it may or may not contain other plant items.

3.3.33 plant system

a part of a process plant (see **3.3.37**) that provides or performs, or is intended to provide or perform, a service or function contributing to, or enabling the operation of, a process plant. A plant system consists of an assembly (see **3.3.2**) of one or more plant items (see **3.3.32**). A plant system has both physical (see **3.3.24**) and functional (see **3.3.13**) aspects

3.3.34 process activity

an activity that transforms or transports process material (see **3.3.36**) between its input to a process plant (see **3.3.37**) as feed stock and its output from a process plant as a product or waste

NOTE The transformation can be a change of physical (see **3.3.24**) state, a physical separation or mixing, or a biological or chemical process.

3.3.35 process flow diagram

a schematic representation (see **3.3.40**) that consists, as a minimum, of the connection of process activities (see **3.3.34**) by material streams (see **3.3.23**) and the identification of plant items (see **3.3.32**) that perform the process activities

NOTE 1 The process activities (see **3.3.34**) shown on a process flow diagram can also be called unit operations.

NOTE 2 The process flow diagram can also present:

- properties of process activities (see **3.3.34**) and material streams (see **3.3.23**) for particular cases;
- measurements that are made upon process activities and material streams;
- the flow of signals between sensors, controllers, and actuators;
- the control logic that is implemented by a controller.

3.3.36 process material

the material (see **3.3.22**) that is transformed or transported by a process activity (see **3.3.34**)

3.3.37 process plant

an assembly (see **3.3.2**) of one or more plant systems (see **3.3.33**) and plant items (see **3.3.32**) that can, or is intended to perform, a chemical, physical (see **3.3.24**) or transport process. A process plant is identified as a single unit for the purposes of management and ownership. A process plant has both physical and functional (see **3.3.13**) aspects

3.3.38 range of values

a specification of a value range for a given dimension, parameter, or nominal size, for the purpose of defining a family of plant items (see **3.3.32**)

NOTE This is done by specifying two dimensional values for a given parameter. One dimension has a name with a value of minimum_<parameter name>, such as minimum_flange_inside_diameter. The other dimension has a name with a value of maximum_<parameter name>, such as maximum_flange_inside_diameter.

3.3.39 range value

an indication of variation of a dimension, parameter, or nominal size on an actual physical (see **3.3.24**) plant item (see **3.3.32**). A range value is not a toleranced dimension. A range value, like the range of values (see **3.3.38**), has a minimum and maximum value. It does not, however, indicate a family of plant items

NOTE The attributes that use range values in 4.2 are differentiated from those attributes that use range of values (see **3.3.38**) by an explanatory note that follows the attribute definition.

EXAMPLE Insulation (see **3.3.17**) may be described as 6 inches thick, but in reality it may be 5-7 inches thick. Range values permit this to be specified.

3.3.40 representation

a description, drawing, or depiction of something

3.3.41 required

descriptive adjective that, when applied to an item, indicates that an item is essential or necessary, i.e., it has to be provided to satisfy a functional (see **3.3.13**) need

NOTE 1 The terms actual (see **3.3.1**), planned (see **3.3.31**), and required loosely reflect life-cycle stages of an item.

NOTE 2 Within the scope of this part of ISO 10303, being required can be specified for an item that is:

- a plant item (see **3.3.32**);
- an association between plant items such as a connection (see **3.3.8**);
- an activity or an association between a plant item and an activity;
- a possession of a property by a plant item or activity.

3.3.42 site

an area of land or water that one or more process plants (see **3.3.37**) is or may be situated on

3.3.43 spatial configuration

the location, orientation, and relative position of the components (see **3.3.7**) of a plant system (see **3.3.33**)

3.4 Abbreviations

For the purposes of this part of ISO 10303, the following abbreviations apply:

AAM	application activity model
AE	architectural engineering
AEC	architecture, engineering, and construction
AIC	application interpreted construct
AIM	application interpreted model
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
AP	application protocol

ARM	application reference model
ASTM	American Society for Testing and Materials
ATS	abstract test suite
Brep	boundary representation
BOP	bottom of pipe
CAD	computer-aided design
CC	conformance class
COP	centre of pipe
CSG	constructive solid geometry
ECN	engineering change notice
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
GIS	geographic information system
GUID	globally unambiguous identifier
HVAC	heating, ventilation, and air conditioning
id	identifier
ICOM	input, control, output, or mechanism
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
OSHA	Occupational Safety and Health Administration
PFD	process flow diagram
P&ID	piping and instrumentation diagram
PICS	protocol information and conformance statement
PIEBASE	Process Industry Executive for achieving Business Advantage using Standards for data Exchange
PSI	pounds per square inch
UoF	unit of functionality

4. Information requirements

This clause specifies the information required for the exchange of plant spatial configuration information between application systems.

The information requirements are specified as a set of units of functionality, application objects, and application assertions. These assertions pertain to individual application objects and to relationships between application objects. The information requirements are defined using the terminology of the subject area of this application protocol.

NOTE 1 A graphical representation of the information requirements is given in annex G.

NOTE 2 The information requirements correspond to those of the activities identified as being in the scope of this application protocol in annex F.

NOTE 3 The mapping table specified in 5.1 shows how the integrated resources are used to meet the information requirements of this application protocol. The use of the integrated resources introduces additional requirements that are common to application protocols.

4.1. Units of functionality

This subclause specifies the UoFs for the plant spatial configuration application protocol. This part of ISO 10303 specifies the following units of functionality:

- cableway_component_characterization UoF;
- change_information UoF;
- connection UoF;
- connector UoF;
- hvac_component_characterization UoF;
- hvac_system_functional_characterization UoF;
- hybrid_shape_representation UoF;
- piping_component_characterization UoF;
- piping_inspection UoF;
- piping_system_functional_characterization UoF;
- plant_characterization UoF;
- plant_csg_shape_representation UoF;
- plant_item_characterization UoF;
- shape UoF;
- site_characterization UoF.

The units of functionality and a description of the functions that each UoF supports are given below. The application objects included in the UoFs are defined in 4.2.

4.1.1. cableway_component_characterization UoF

The cableway_component_characterization UoF describes the physical representation of cableway systems and elements. This UoF extends the plant_characterization UoF for characterization of cableway systems and extends the plant_item_characterization UoF for representation of cableway components. The geometry of cableway components is specified using the shape UoF.

The following application objects are used by the cableway_component_characterization UoF:

- Cable;
- Cableway_component;
- Cableway_connector;
- Cableway_fitting;
- Cableway_piece;
- Cableway_size_description;
- Conduit;
- Conduit_size_description;
- Raceway;
- Raceway_lane;
- Raceway_size_description.

4.1.2. change_information UoF

The change_information UoF describes information such as the design change requests and approvals for modifications to Plant objects, Plant_item objects, Plant_system objects, and other components associated with the Plant.

The following application objects are used by the change_information UoF:

- Change;
- Change_approval;
- Change_item;
- Change_life_cycle_stage;
- Change_life_cycle_stage_sequence;
- Change_life_cycle_stage_usage;
- Changed_line_assignment;
- Changed_line_branch_connection;
- Changed_line_plant_item_branch_connection;
- Changed_line_plant_item_connection;
- Changed_line_to_line_connection;

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- Changed_piping_specification;
- Changed_piping_system_line;
- Changed_piping_system_line_segment;
- Changed_piping_system_line_segment_termination;
- Changed_planned_physical_plant;
- Changed_plant;
- Changed_plant_item;
- Changed_plant_item_collection;
- Changed_plant_item_connection;
- Changed_plant_item_connector;
- Changed_plant_item_location;
- Changed_plant_item_shape;
- Changed_plant_process_capability;
- Changed_plant_system;
- Changed_reference_geometry;
- Changed_required_material_description;
- Changed_site;
- Changed_site_feature;
- Changed_sited_plant;
- Changed_sub_plant_relationship.

4.1.3. connection UoF

The connection UoF describes the physical linkage or connectivity between Plant_item objects. Plant_item objects have connectors. Two connectors of a compatible type are attached to form a connection. The sequence of connections establishes the physical connectivity of items within Plant_system objects.

The following application objects are used by the connection UoF:

- Connection_definition;

- Electricity_transference;
- Flexible_connection;
- Fluid_transference;
- Functional_connection_definition_satisfaction;
- Functional_connection_occurrence_satisfaction;
- Load_transference;
- Locked_orientation_connection;
- Plant_item_connection;
- Plant_item_connection_occurrence.

4.1.4. connector UoF

The connector UoF is the information about the part of a Plant_item that is intended to interconnect with another Plant_item. This UoF describes the physical features of Plant_item objects that are designed to connect or mate with a similar physical feature on another Plant_item object.

The following application objects are used by the connector UoF:

- Branch_hole;
- Buttweld;
- Catalogue_connector;
- Clamped;
- Connector_definition;
- Cross_section_flat_oval;
- Cross_section_non_standard;
- Cross_section_radiused_corner;
- Cross_section_rectangular;
- Cross_section_round;
- Cross_section_triangular;
- Electrical_connector;
- Female_end;

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- Flanged;
- Flanged_end;
- Flared_end;
- Functional_connector;
- Functional_connector_definition_satisfaction;
- Functional_connector_occurrence_satisfaction;
- Grooved_end;
- Hvac_branch_connection;
- Hvac_connector;
- Hvac_connector_service_characteristic;
- Hvac_cross_section;
- Hvac_plant_item_branch_connector;
- Hvac_plant_item_connector;
- Male_end;
- Node;
- Physical_connector;
- Piping_connector;
- Piping_connector_service_characteristic;
- Plant_item_connector;
- Plant_item_connector_occurrence;
- Pressure_fit;
- Service_operating_case;
- Socket;
- Structural_load_connector;
- Stub_in;
- Threaded.

4.1.5. **hvac_component_characterization UoF**

The `hvac_component_characterization` UoF describes the physical representation of HVAC systems and elements. This UoF extends the `plant_item_characterization` UoF for representation of `Hvac_component` objects. The geometry of `Hvac_component` objects is specified using the `shape` UoF.

The following application objects are used by the `hvac_component_characterization` UoF:

- `Hvac_access_opening`;
- `Hvac_bend`;
- `Hvac_component`;
- `Hvac_component_thickness`;
- `Hvac_coupling`;
- `Hvac_elbow_90deg_reducing`;
- `Hvac_elbow_centred`;
- `Hvac_elbow_mitre`;
- `Hvac_end_fitting`;
- `Hvac_equipment`;
- `Hvac_fitting`;
- `Hvac_flow_control_device`;
- `Hvac_gasket`;
- `Hvac_instrument`;
- `Hvac_offset_centred`;
- `Hvac_offset_ogee_centred`;
- `Hvac_takeoff`;
- `Hvac_transition`;
- `Hvac_transition_slanted`;
- `Splitter`.

4.1.6. hvac_system_functional_characterization UoF

The hvac_system_functional_characterization UoF describes the functional representation of HVAC systems and elements. It extends the plant_characterization UoF.

The following application objects are used by the hvac_system_functional_characterization UoF:

- Hvac_plant_item_branch_connection;
- Hvac_plant_item_connection;
- Hvac_plant_item_termination;
- Hvac_section_branch_termination;
- Hvac_section_segment;
- Hvac_section_segment_insulation;
- Hvac_section_segment_termination;
- Hvac_section_termination;
- Hvac_section_to_section_connection;
- Hvac_section_to_section_termination;
- Hvac_specification;
- Hvac_system_section.

4.1.7. hybrid_shape_representation UoF

The hybrid_shape UoF specifies the representation of Plant_item shapes using Brep geometry and topology.

The following application objects are used by the hybrid_shape UoF:

- B_rep_element;
- Conic;
- Curve;
- Free_form_curve;
- Line;
- Point;
- Polygon;

- Surface;
- Vector;
- Wire_and_surface_element.

4.1.8. piping_component_characterization UoF

The piping_component_characterization UoF describes the individual elements of the Piping_system within a Plant. Piping_component objects include pipes, fittings, valves, in-line equipment, and other elements that regulate, control, or convey Piping_system fluids.

The following application objects are used by the piping_component_characterization UoF:

- Base_elbow_support;
- Base_line_support;
- Blank;
- Blind_flange;
- Boss;
- Bushing;
- Cap;
- Compound_bend_pipe;
- Coupling;
- Cross;
- Dummy_leg;
- Eccentric_base_elbow_support;
- Eccentric_reducer;
- Elbow;
- Expander_flange;
- Family_definition;
- Ferrule;
- Fitting;
- Flange;

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- Gasket;
- Gusset;
- Inline_equipment;
- Inline_instrument;
- Insert;
- Inside_and_thickness;
- Lap_joint_flange;
- Lap_joint_stub_end;
- Lateral;
- Lined_piping;
- Lug;
- Mitre_bend_pipe;
- Nipple;
- Olet;
- Orifice_flange;
- Orifice_plate;
- Outside_and_thickness;
- Paddle_blank;
- Paddle_spacer;
- Perforated_plate;
- Pipe;
- Pipe_closure;
- Piping_component;
- Piping_size_description;
- Piping_spool;
- Piping_support;

- Plate;
- Plug;
- Pressure_class;
- Reducer;
- Reducing_flange;
- Reinforcing_component;
- Reinforcing_plate;
- Ring_spacer;
- Schedule;
- Shoe;
- Slip_on_flange;
- Slip_on_jacket_flange;
- Socket_weld_flange;
- Spacer;
- Specialty_item;
- Spectacle_blind;
- Stay;
- Stopper;
- Straight_pipe;
- Swept_bend_pipe;
- Tee;
- Threaded_flange;
- Union;
- Valve;
- Weld_neck_flange;
- Weld_neck_jacket_flange;
- Y_type_lateral.

4.1.9. piping_inspection UoF

The piping_inspection UoF describes inspection information and inspection documentation for Piping_component objects and Piping_spool objects.

The following application objects are used by the hvac_component_characterization UoF:

- Connection_inspection_record;
- Inspection_condition;
- Piping_component_inspection_record;
- Piping_spool_inspection_record;
- Shape_inspection_record.

4.1.10. piping_system_functional_characterization UoF

The piping_system_functional_characterization UoF describes the functional connectivity of a Piping_system and the functional connectivity among Plant_item objects in that system. This UoF provides the information that describes the functional links and properties of a flow stream in a Piping_system. It includes information about the segments in the line and the specifications for these segments, such as design criteria, service conditions, and line identifier.

The following application objects are used by the piping_system_functional_characterization UoF:

- Line_branch_connection;
- Line_branch_termination;
- Line_piping_system_component_assignment;
- Line_plant_item_branch_connection;
- Line_plant_item_branch_connector;
- Line_plant_item_connection;
- Line_plant_item_connector;
- Line_plant_item_termination;
- Line_to_line_connection;
- Line_to_line_termination;
- Piping_specification;

- Piping_system_line;
- Piping_system_line_segment;
- Piping_system_line_segment_termination;
- Piping_system_line_termination;
- Segment_insulation;
- Stream_design_case;
- Stream_phase.

4.1.11. plant_characterization UoF

The plant_characterization UoF describes identifiable collections of Plant_item objects that perform specific functions within a plant. The Plant_item objects are functionally dependent on one another for the performance of the system and are interrelated through physical connections. The collection of Plant_system objects as a whole enables the Plant to operate.

The following application objects are used by the plant_characterization UoF:

- Cableway_system;
- Ducting_system;
- Electrical_system;
- External_classification;
- Functional_plant;
- Functional_plant_satisfaction;
- Hvac_system;
- Instrumentation_and_control_system;
- Line_less_piping_system;
- Location_in_plant;
- Manufacturing_line;
- Piping_system;
- Planned_physical_plant;
- Plant;

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- Plant_process_capability;
- Plant_system;
- Plant_system_assembly;
- Structural_system;
- Sub_plant_relationship;
- Train;
- Unit.

4.1.12. plant_csg_shape_representation UoF

The plant_csg_shape UoF specifies the representation of Plant_item shapes using CSG primitives.

The following application objects are used by the plant_csg_shape UoF:

- Block;
- Circular_ellipsoid;
- Cone;
- Csg_element;
- Cylinder;
- Eccentric_cone;
- Eccentric_cylinder;
- Eccentric_pyramid;
- Extrusion;
- Faceted_brep;
- Hemisphere;
- Pyramid;
- Reducing_torus;
- Solid_of_revolution;
- Sphere;

- Square_to_round;
- Torus;
- Trimmed_block;
- Trimmed_cone;
- Trimmed_cylinder;
- Trimmed_pyramid;
- Trimmed_sphere;
- Trimmed_torus.

4.1.13. plant_item_characterization UoF

The plant_item_characterization UoF describes major elements that Plant objects and Plant_system objects are comprised of. These are items within a Plant that occupy space and possess physical, measurable characteristics. This UoF specifies spatial and physical information about Piping_system_component objects and Equipment, but only spatial characteristics of components of other Plant_system objects, such as hvac and instrumentation.

This UoF describes the information and options associated with the specification of the substance or substances that a Plant_item is composed of. It also describes specification and catalogue information concerning piping components.

This UoF describes the spatial shape and position of volumes of space in a Plant.

NOTE 1 Physical plant_items are things that can be touched.

NOTE 2 As used in this part of ISO 10303, material does not refer to the products that flow within plant systems.

The following application objects are used by the plant_item_characterization UoF:

- Analysis_data_point;
- Bolt;
- Bolt_and_nut_component;
- Bolt_and_nut_set;
- Cable_support;
- Catalogue_definition;
- Catalogue_item;
- Catalogue_item_substitute;

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- Clamp;
- Clamp_set;
- Connected_collection;
- Connection_component;
- Connection_material;
- Design_project;
- Document;
- Ducting_component;
- Electrical_component;
- Equipment;
- Equipment_breaching;
- Equipment_trim_piping;
- Externally_defined_document;
- Externally_defined_user_defined_attribute_value;
- Functional_design_view;
- Functional_plant_item_satisfaction;
- Hexagon_head_bolt;
- Hierarchically_organized_collection;
- Hvac_ducting;
- Installed_physical_design_view;
- Instrument;
- Instrumentation_and_control_component;
- Insulation;
- Material_specification_selection;
- Material_specification_subset_reference;
- Nozzle;

- Nut;
- Offline_instrument;
- Physical_design_view;
- Piping_assembly;
- Piping_assembly_assignment;
- Piping_system_component;
- Plain_washer;
- Planned_physical_plant_item;
- Plant_item;
- Plant_item_collection;
- Plant_item_definition;
- Plant_item_design_view;
- Plant_item_instance;
- Plant_item_location;
- Plant_item_weight;
- Plant_volume;
- Process_ducting;
- Project_design_assignment;
- Relative_item_location;
- Required_material_description;
- Reserved_space;
- Route;
- Spare_plant_item_usage;
- Spring_washer;
- Structural_component;
- Stud_bolt;
- Supplied_equipment;

- Supplier;
- Support_component;
- Support_constraints;
- Support_usage;
- Support_usage_connection;
- System_space;
- Toothed_lock_washer;
- Trunnion;
- User_defined_attribute_value;
- Washer.

4.1.14. shape UoF

The shape UoF specifies the external shapes of components, assemblies of components, and volumes of a Plant. The external shape of a component can be specified as an envelope of the space occupied by a component, as an outline of the component, or as a detailed definition of the shape of a component.

The following application objects are used by the shape UoF:

- Detail_shape;
- Envelope_shape;
- Hybrid_shape_representation;
- Interfering_shape_element;
- Outline_shape;
- Plant_csg_shape_representation;
- Plant_item_centreline;
- Plant_item_interference;
- Plant_item_interference_status;
- Plant_item_shape;
- Reference_geometry;

- Shape_interference_zone_usage;
- Shape_parameter;
- Shape_representation;
- Shape_representation_element;
- Shape_representation_element_usage.

4.1.15. site_characterization UoF

The site_characterization UoF describes the significant features of the Site where the Plant is located. It includes information about the site location, infrastructure like roads and sewers, buildings, and other structures located on the Site, and the shape of the terrain where a Building or Site_feature is located.

The following application objects are used by the site_characterization UoF:

- Breakline;
- Building;
- Facet_trigon;
- Faceted_surface_representation;
- Gis_position;
- Location_in_building;
- Location_in_site;
- Point_and_line_representation;
- Site;
- Site_feature;
- Site_shape_representation;
- Sited_plant;
- Survey_point.

4.2. Application objects

This subclause specifies the application objects for the plant spatial configuration application protocol. Each application object is an atomic element that embodies a unique application concept and contains attributes specifying the data elements of the object. The application objects and their definitions are given below.

Each application object attribute need not be present unless the attribute is specifically identified as required for an application object.

4.2.1. Analysis_data_point

An Analysis_data_point is an identifiable point in space that has a relationship to some Plant_item (see **4.2.260**). Analysis_data_point serves as an anchor for contexts external to this part of ISO 10303 allowing information from these external contexts to reference data that is within the scope and format specified in this part of ISO 10303.

The data associated with an Analysis_data_point are the following:

- id;
- name;
- location.

4.2.1.1 id

The id specifies a unique identifier for the Analysis_data_point.

4.2.1.2 name

The name specifies a textual label given to the Analysis_data_point.

4.2.1.3 location

The location specifies the relative position of the Analysis_data_point within the Plant (see **4.2.258**). This location need not be within the envelope of the Plant_item (see **4.2.260**) with which this Analysis_data_point is associated.

4.2.2. B_rep_element

A B_rep_element is a type of Shape_representation_element (see **4.2.310**) that is composed of geometric and topological elements.

NOTE A B_rep_element need not represent a solid shape.

4.2.3. Base_elbow_support

A **Base_elbow_support** is a **Piping_support** (see 4.2.248) that is attached to a corner of bent part. The main body of the **Base_elbow_support** is a pipe with a base plate that is attached at the foot of the main body of the support. The **Base_elbow_support** is placed vertically and supports the weight of the piping assembly at the base plate.

NOTE Figure 3 depicts a non-adjustable and an adjustable **Base_elbow_support**.

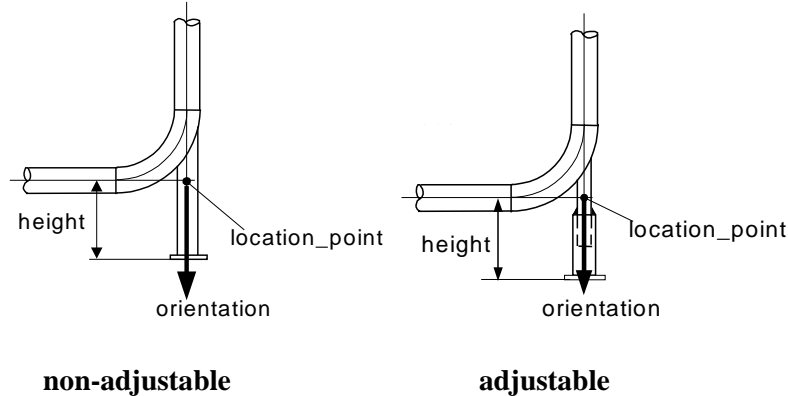


Figure 3 - Base_elbow_support

The data associated with a **Base_elbow_support** are the following:

- height;
- adjustability.

4.2.3.1 height

The height is the distance between the supporting face of the base plate of **Base_elbow_support** and the **location_point**.

4.2.3.2 adjustability

The adjustability specifies a designation that classifies a **Base_elbow_support** based on variability of its height. The value of adjustability shall be one of the following:

- adjustable;
- non adjustable.

4.2.4. Base_line_support

A **Base_line_support** is a type of **Piping_support** (see 4.2.248) that is attached to a horizontal pipe. The main body of the **Base_line_support** is usually a pipe, but shape steel or plate is occasionally used as the material of the support. The base plate is attached at the foot of the main body of the **Base_line_support**. The **Base_line_support** is placed vertically and supports the weight of the piping assembly to which it is attached at the base plate.

NOTE Figure 4 depicts a typical **Base_line_support**.

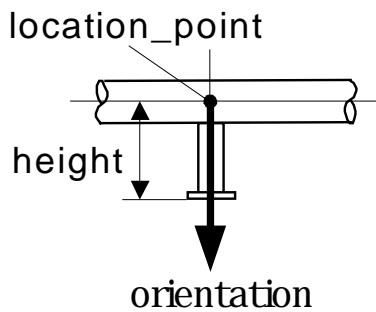


Figure 4 - Base_line_support

The data associated with a Base_line_support are the following:

- height;
- spring.

4.2.4.1 height

The height specifies the distance between the supporting face of the base plate of the Base_line_support and the location_point.

4.2.4.2 spring

The spring specifies whether the Base_line_support contains a spring. The value of spring is one of the following:

- with_spring;
- without_spring.

4.2.5. Blank

A Blank is a type of Fitting (see **4.2.117**) that is placed between two Flange (see **4.2.119**) objects to block the flow of material between the pipelines on either side of the Blank. Each Blank may be one of the following: a Paddle_blank (see **4.2.230**) or a Spectacle_blind (see **4.2.325**).

The data associated with a Blank are the following:

- outside_diameter;
- thickness.

4.2.5.1 outside_diameter

The `outside_diameter` specifies the external diameter of the Blank. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.5.2 thickness

The `thickness` specifies the distance between the two faces of the Blank. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.6. Blind_flange

A `Blind_flange` is a type of `Flange` (see 4.2.119) that is used to block material flow at a flanged connection.

NOTE Figure 5 depicts a typical `Blind_flange`.

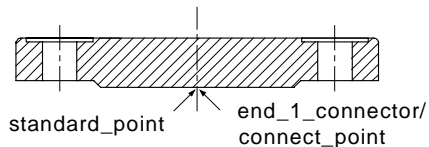


Figure 5 - Blind_flange

4.2.7. Block

A `Block` is a type of `Csg_element` (see 4.2.84) that is a 3D right rectangular solid.

NOTE The size and shape of a `Block` is described by three real values representing the dimensions of the `Block`.

4.2.8. Bolt

A `Bolt` is a type of `Bolt_and_nut_component` (see 4.2.9) that is used to fasten two or more `Plant_items` (see 4.2.260) together. The `Bolt` is a rod with a hexagonal, square or round head at one end and a screw thread on the other, or with screw threads on both ends.

The data associated with a `Bolt` are the following:

— bolt_type.

The bolt_type specifies a classification of the Bolt based on its shape characteristics.

EXAMPLE Examples of bolt_type designations include hexagon_head, and stud.

4.2.9. Bolt_and_nut_component

A Bolt_and_nut_component is a type of Connection_component (see **4.2.71**) that is a constituent element of a Bolt_and_nut_set (see **4.2.10**). Each Bolt_and_nut_component may be one of the following: a Bolt (see **4.2.8**), a Nut (see **4.2.223**), or a Washer (see **4.2.369**).

The data associated with a Bolt_and_nut_component are the following:

— nominal_size;

— quantity.

4.2.9.1 nominal_size

The nominal_size specifies a standard size designation of the Bolt_and_nut_component. It may be specified as a single value or as a range of values.

NOTE 1 The nominal size need not represent an actual dimension.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.9.2 quantity

The quantity specifies the number of Bolt_and_nut_components used in a Bolt_and_nut_set (see **4.2.10**).

4.2.10. Bolt_and_nut_set

A Bolt_and_nut_set is a Connection_material (see **4.2.74**) that consists of Bolt_and_nut_components (see **4.2.9**) and the Bolt_and_nut_set shall contain at least one Bolt_and_nut_component such as a Bolt (see **4.2.8**), a Nut (see **4.2.223**), or a Washer (see **4.2.369**). The Bolt_and_nut_set is used to connect Piping_components (see **4.2.240**).

The data associated with a Bolt_and_nut_set are the following:

— set_id;

— quantity_used.

4.2.10.1 set_id

The set_id specifies a unique identifier for the Bolt_and_nut_set. The set_id is required for each Bolt_and_nut_set.

4.2.10.2 quantity_used

The `quantity_used` specifies the number of `Bolt_and_nut_sets` used at a `Plant_item_connection` (see 4.2.263).

4.2.11. Boss

A Boss is an Olet (see 4.2.225) that is welded onto a pipe perpendicular to the straight run of the pipe. The Boss consists of a counter-bored shape with a Socket (see 4.2.319) on the outside.

NOTE Figure 6 depicts a typical Boss with two different welding types.

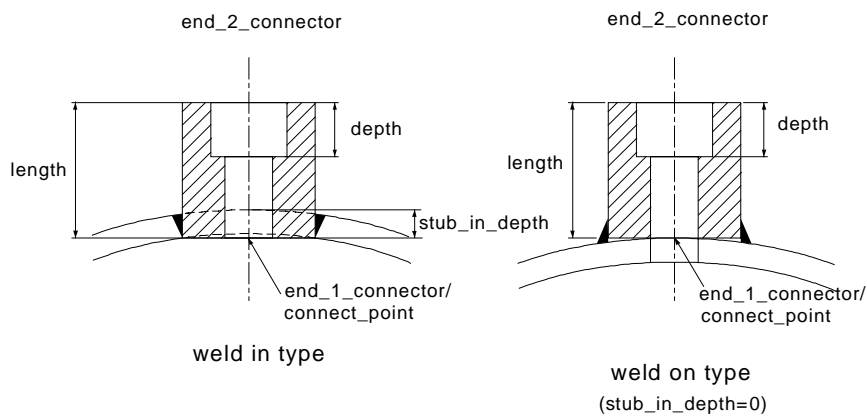


Figure 6 - Boss

The data associated with a Boss are the following:

— `depth`.

The `depth` specifies the distance from the outer face of the `end_2_connector` to the bottom of the socket. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.12. Branch_hole

A `Branch_hole` is a type of `Piping_connector` (see 4.2.242) end type that is a hole cut in a pipe for a branch connection.

NOTE A `Branch_hole` is not typically a design feature of the pipe, but rather is added after the fact to create a branch from the pipe. The hole may be used for stub-in connections, olets, or nipples can be welded or screwed to it.

The data associated with a `Branch_hole` are the following:

— `diameter`;

— `stub_in_depth`.

4.2.12.1 diameter

The `diameter` specifies the diameter value of the `Branch_hole`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.12.2 stub_in_depth

The stub_in_depth specifies the distance from the end of a stubbed-in Piping_component (see 4.2.240) to the point where the centreline of the stubbed-in Piping_component intersects the outer surface of the other Piping_component. It may be specified as a single value or as a range of values.

NOTE 1 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

NOTE 2 The attribute for stub_in_depth will only be used when the Piping_component (see 4.2.240) participates in a connection.

4.2.13. Breakline

A Breakline is a contiguous set of straight line segments that designate a path across a Site_shape_representation (see 4.2.315).

NOTE The path is a constraint on the mathematical interpolation of the surface of the terrain.

4.2.14. Building

A Building is a partially or totally enclosed structure located on a Site (see 4.2.313) that contains Plant_system (see 4.2.276) objects or provides supporting infrastructure within its boundaries. The z-axis of the local coordinate system of the Building shall be considered the elevation of the coordinate space.

The data associated with a Building are the following:

- building_id;
- location_and_orientation;
- name;
- shape.

4.2.14.1 building_id

The building_id specifies a unique number used to identify the building. Building_id is required for each Building.

4.2.14.2 location_and_orientation

The location_and_orientation specifies the position of the Building relative to the site coordinate system and the orientation of the Building relative to a specified direction.

EXAMPLE E5704.35', N5912.87' are coordinates. They can be used to locate a known point in the Building (e.g., centrelines of column row 1A).

4.2.14.3 name

The name specifies a textual label given to the Building.

4.2.14.4 shape

The shape specifies the outline or characteristic surface configuration or contour of the building.

4.2.15. Bushing

A Bushing is a type of Fitting (see 4.2.117) with one external and one smaller internal end.

NOTE Figure 7 depicts a typical threaded hexagon Bushing. It is typically used to connect a smaller Pipe (see 4.2.236) to a larger Fitting or Nozzle.

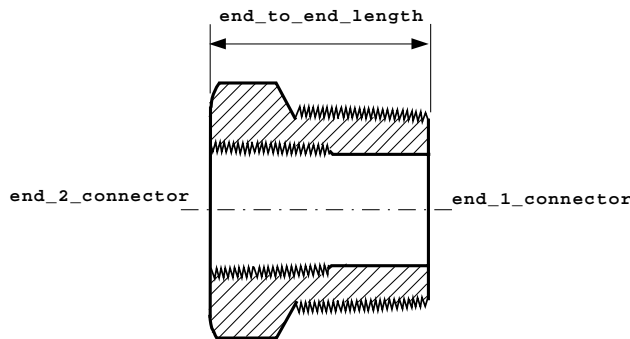


Figure 7 - Bushing

The data associated with a Bushing are the following:

- end_1_connector;
- end_2_connector;
- end_to_end_length.

4.2.15.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.242) Male_end (see 4.2.215).

4.2.15.2 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.242) Female_end (see 4.2.116).

4.2.15.3 end_to_end_length

The end_to_end_length specifies the external length of the Bushing from the end-one face to the end-two face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.16. Buttweld

A Buttweld is a type of Piping_connector (see **4.2.242**) that consists of the welding of two Piping_component (see **4.2.240**) objects where they are aligned edge to edge.

The data associated with a Buttweld are the following:

— root_gap.

The root_gap specifies the distance between the end faces of two Piping_components (see **4.2.240**) that are buttwelded. It may be specified as a single value or as a range of values.

NOTE 1 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

NOTE 2 The attribute for root_gap will only be used when the Piping_component (see **4.2.240**) participates in a connection.

4.2.17. Cable

A Cable is a group of one or more electrical conductors bound together to follow the same path through space, and insulated from each other.

EXAMPLE Multi-conductor power cables, bus bars, twisted-pair ethernet cables, fiber-optic cables, telephone cables, hook-up wire.

4.2.18. Cable_support

A Cable_support is a type of Support_component (see **4.2.343**) that provides support to Electrical_component (see **4.2.99**) objects.

The data associated with a Cable_support are the following:

— cable_support_type.

The cable_support_type specifies a description of the category of Cable_support.

4.2.19. Cableway_component

A Cableway_component is a type of Plant_item (see **4.2.260**) that is a part of a Cableway_system (see **4.2.24**). Each Cableway_component may be a Cableway_piece (see **4.2.22**), a Cableway_fitting (see **4.2.21**), or a Raceway_lane (see **4.2.290**).

4.2.20. Cableway_connector

A Cableway_connector is a type of Plant_item_connector (see 4.2.265) that establishes a link between two Cableway_component (see 4.2.19) objects.

The data associated with a Cableway_connector are the following:

— type.

The type specifies the kind of Cableway_connector.

4.2.21. Cableway_fitting

A Cableway_fitting is a type of Cableway_component (see 4.2.19) that joins or fits two other Cableway_components (see 4.2.19) together.

4.2.22. Cableway_piece

A Cableway_piece is a type of Cableway_component (see 4.2.19) that has one or more channels through which Cable (see 4.2.17) objects may be run. Each Cableway_piece is either a Raceway (see 4.2.289) or a Conduit (see 4.2.66).

4.2.23. Cableway_size_description

A Cableway_size_description is used to explain or summarize the physical size of a Cableway_component (see 4.2.19) or Cableway_connector (see 4.2.20), based on a set of dimensional characteristics. Each Cableway_size_description is either a Raceway_size_description (see 4.2.291) or a Conduit_size_description (see 4.2.67).

The data associated with a Cableway_size_description are the following:

— fill_area.

The fill_area specifies the cross-sectional area of the usable portion of the cavity within a Cableway_component (see 4.2.19) that is available to be filled with Cable (see 4.2.17) objects.

4.2.24. Cableway_system

A Cableway_system is a type of Plant_system (see 4.2.276) that is a system of interconnected Cableway_component (see 4.2.19) objects form a series of channels to hold Cable (see 4.2.17) objects.

4.2.25. Cap

A Cap is a type of Pipe_closure (see 4.2.237) which closes the end of the pipe.

NOTE Figure 8 depicts a typical welded round Cap.

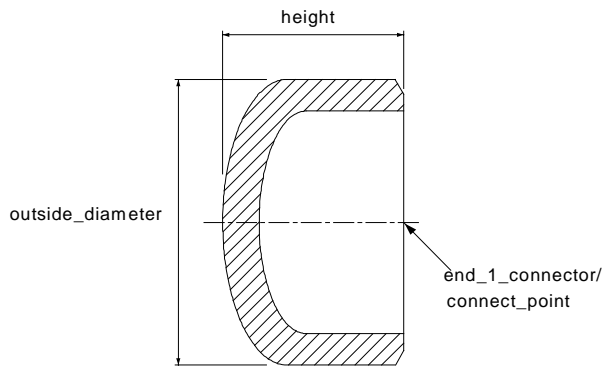


Figure 8 - Cap

The data associated with a Cap are the following:

— height.

The height is the distance between the end and the top of the Cap.

4.2.26. Catalogue_connector

A Catalogue_connector is the definition or the reference of a Connector_definition (see 4.2.75). A Connector_definition may appear in a catalogue, or the properties of a Connector_definition may be drawn from a catalogue.

NOTE A Catalogue_connector is analogous to a Catalogue_item (see 4.2.28) in that both have standardized characteristics.

4.2.27. Catalogue_definition

A Catalogue_definition is the identification of a document that lists Catalogue_item (see 4.2.28) objects.

NOTE 1 Catalogue_definition may reference either an electronic or printed catalogue.

NOTE 2 A Catalogue_definition may be defined by ISO 13584 [13]. ISO 13584 will be considered a normative reference when it has reached the DIS level.

The data associated with a Catalogue_definition are the following:

— catalogue_id;

— catalogue_name;

— catalogue_version.

4.2.27.1 catalogue_id

The catalogue_id specifies a unique identifier given to a catalogue. Catalogue_id is required for each Catalogue_definition.

4.2.27.2 catalogue_name

The catalogue_name specifies a textual label given to the catalogue.

4.2.27.3 catalogue_version

The catalogue_version specifies a particular release of a catalogue within a sequence of catalogue releases.

4.2.28. Catalogue_item

A Catalogue_item is an item whose characteristics are standardized and have been categorized in a library or catalogue. A Catalogue_item that is defined by a Plant_item_definition (see **4.2.267**) must be defined by a Plant_item_definition in which the Plant_item (see **4.2.260**) is defined as a Physical_design_view (see **4.2.235**).

The data associated with a Catalogue_item are the following:

- item_name;
- item_version;
- model_number.

4.2.28.1 item_name

The item_name specifies a textual label that is used by the supplier to refer to the Catalogue_item.

4.2.28.2 item_version

The item_version specifies a particular release of a Catalogue_item within a sequence of Catalogue_item releases.

NOTE This attribute accommodates the possibility of revision pages to a supplier catalogue.

4.2.28.3 model_number

The model_number is the identifier assigned by the supplier to one or more Catalogue_item objects.

4.2.29. Catalogue_item_substitute

A Catalogue_item_substitute is an alternate Catalogue_item (see **4.2.28**) that can be used instead of the specified Catalogue_item.

4.2.30. Change

A Change is the modification or requested modification of a Plant_item (see **4.2.260**).

NOTE A Change may be a request to make a change or an approved change.

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The data associated with a Change are the following:

- business_unit;
- change_id;
- change_reason;
- change_summary;
- date;
- project_number;
- revision;
- title.

4.2.30.1 business_unit

The business_unit specifies the organization(s), company(s), or functional group(s) responsible for the Change.

4.2.30.2 change_id

The change_id specifies a unique identifier for the Change.

4.2.30.3 change_reason

The change_reason specifies the rationale for the Change.

4.2.30.4 change_summary

The change_summary specifies a general description of the Change.

4.2.30.5 date

The date specifies the calendar day-month-year and time that the Change was initiated on.

NOTE A specific ordering of the day, month, and year within the date is not required.

4.2.30.6 project_number

The project_number specifies a designation assigned to identify projects within an organization. More than one project (and therefore more than one project_number) may be associated with a Change.

EXAMPLE Identification of a project_number is used to allow tracking of items such as costs and job hours associated with a Change.

NOTE A project_number may or may not be the same as the designation of a Design_project (see **4.2.87**).

4.2.30.7 revision

The revision specifies the particular amendment of the Change within a sequence of amendments.

4.2.30.8 title

The title specifies a descriptive label for the Change.

4.2.31. Change_approval

A Change_approval is the endorsement by an authority of the change in status of a specific Change (see 4.2.30).

The data associated with a Change_approval are the following:

— approval_date;

— approver;

— approver_role.

4.2.31.1 approval_date

The approval_date specifies the specific calendar day-month-year and time when the approval authority signed the Change as approved.

NOTE A specific ordering of the day, month, and year within the date is not required.

4.2.31.2 approver

The approver specifies the name of the individual who endorsed the Change.

4.2.31.3 approver_role

The approver_role specifies the purpose or function of the approver that approves a change.

4.2.32. Change_item

A Change_item is an item that may be modified, for which there is a request to modify, or is the result of a modification to a Change_item. Each Change_item is either: a Changed_line_assignment (see 4.2.36), a Changed_line_branch_connection (see 4.2.37), a Changed_line_plant_item_branch_connection (see 4.2.38), a Changed_line_plant_item_connection (see 4.2.39), a Changed_line_to_line_connection (see 4.2.40), a Changed_piping_system_line (see 4.2.42), a Changed_piping_system_line_segment (see 4.2.43), a Changed_piping_system_line_segment_termination (see 4.2.44), a Changed_planned_physical_plant (see 4.2.45), a Changed_plant (see 4.2.46), a Changed_plant_item (see 4.2.47), a Changed_plant_item_collection (see 4.2.48), a Changed_plant_item_connection (see 4.2.49), a Changed_plant_item_connector (see 4.2.50), a Changed_plant_item_shape (see 4.2.52), a Changed_plant_process_capability (see 4.2.53), a Changed_plant_system (see 4.2.54), a Changed_reference_geometry (see 4.2.55), a Changed_required_material_description (see 4.2.56), a Changed_sited_plant (see 4.2.59), or a Changed_sub_plant_relationship (see 4.2.60).

The data associated with a Change_item are the following:

- creation_date;
- description;
- from_or_to;
- item_owner;
- supersedence_status.

4.2.32.1 creation_date

The creation_date specifies the calendar day-month-year and time that the Change_item is created on.

NOTE A specific ordering of the day, month, and year within the date is not required.

4.2.32.2 description

The description specifies a textual explanation or summary of the item being changed.

4.2.32.3 from_or_to

The from_or_to specifies whether the Change_item object is to be interpreted as the successor or predecessor in a change. The from_or_to shall have one of the following values:

- from;
- to.

4.2.32.3.1 from

from specifies that the Change_item is the predecessor in a change relationship.

4.2.32.3.2 to

to specifies that the Change_item is the successor in a change relationship.

4.2.32.4 item_owner

The item_owner specifies the name of the person or organization that owns the item being changed and is responsible for implementing or approving the change.

4.2.32.5 supersedence_status

The status specifies the textual description of the existence condition of a Change_item.

EXAMPLE Examples of Change_item status include Current, Superseded, and Deleted.

4.2.33. **Change_life_cycle_stage**

A `Change_life_cycle_stage` is a state in the life cycle of the change that indicates or classifies the status or disposition of the change.

The data associated with a `Change_life_cycle_stage` are the following:

— `name`.

The `name` specifies a textual label given to the stage.

EXAMPLE Examples of names include requested, pending, and implemented.

4.2.34. **Change_life_cycle_stage_sequence**

A `Change_life_cycle_stage_sequence` is the mechanism that specifies the sequence of life-cycle stages.

4.2.35. **Change_life_cycle_stage_usage**

A `Change_life_cycle_stage_usage` is the assignment of a `Change` (see 4.2.30) to a particular `Change_life_cycle_stage` (see 4.2.33).

The data associated with a `Change_life_cycle_stage_usage` are the following:

— `date_of_activation`;

— `date_of_completion`;

— `description`.

4.2.35.1 **date_of_activation**

The `date_of_activation` specifies the calendar day-month-year and time when the `Change` was assigned to the `Change_life_cycle_stage`. A specific ordering of the day, month, and year within the date is not required.

4.2.35.2 **date_of_completion**

The `date_of_completion` specifies the calendar day-month-year and time when the `Change` was released from, or completed, the assigned `life_cycle stage`.

4.2.35.3 **description**

The `description` specifies a textual explanation or summary of the assignment of the `Change` to a particular stage.

4.2.36. **Changed_line_assignment**

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A `Changed_line_assignment` is a type of `Change_item` (see **4.2.32**) that identifies a `Line_piping_system_component_assignment` (see **4.2.200**) that is being changed or is the result of a `Change` (see **4.2.30**).

4.2.37. Changed_line_branch_connection

A `Changed_line_branch_connection` is a type of `Change_item` (see **4.2.32**) that identifies a `Line_branch_connection` (see **4.2.197**) that is being changed or is the result of a `Change` (see **4.2.30**).

4.2.38. Changed_line_plant_item_branch_connection

A `Changed_line_plant_item_branch_connection` is a type of `Change_item` (see **4.2.32**) that identifies a `Line_plant_item_branch_connection` (see **4.2.201**) that is being changed or is the result of a `Change` (see **4.2.30**).

4.2.39. Changed_line_plant_item_connection

A `Changed_line_plant_item_connection` is a type of `Change_item` (see **4.2.32**) that identifies a `Line_plant_item_connection` (see **4.2.203**) that is being changed or is the result of a `Change` (see **4.2.30**).

4.2.40. Changed_line_to_line_connection

A `Changed_line_to_line_connection` is a type of `Change_item` (see **4.2.32**) that identifies a `Line_to_line_connection` (see **4.2.206**) that is being changed or is the result of a `Change` (see **4.2.30**).

4.2.41. Changed_piping_specification

A `Changed_piping_specification` is a type of `Change_item` (see **4.2.32**) that identifies a `Piping_specification` (see **4.2.245**) that is being changed or is the result of a `Change` (see **4.2.30**).

4.2.42. Changed_piping_system_line

A `Changed_piping_system_line` is a type of `Change_item` (see **4.2.32**) that identifies a `Piping_system_line` (see **4.2.251**) that is being changed or is the result of a `Change` (see **4.2.30**).

4.2.43. Changed_piping_system_line_segment

A `Changed_piping_system_line_segment` is a type of `Change_item` (see **4.2.32**) that identifies a `Piping_system_line_segment` (see **4.2.252**) that is being changed or is the result of a `Change` (see **4.2.30**).

4.2.44. Changed_piping_system_line_segment_termination

A `Changed_piping_system_line_segment_termination` is a type of `Change_item` (see 4.2.32) that identifies a `Piping_system_line_segment_termination` (see 4.2.253) that is being changed or is the result of a `Change` (see 4.2.30).

4.2.45. `Changed_planned_physical_plant`

A `Changed_planned_physical_plant` is a type of `Change_item` (see 4.2.32) that identifies a `Planned_physical_plant` (see 4.2.256) that is being changed or is the result of a `Change` (see 4.2.30).

4.2.46. `Changed_plant`

A `Changed_plant` is a type of `Change_item` (see 4.2.32) that identifies a `Plant` (see 4.2.258) that is being changed or is the result of a `Change` (see 4.2.30).

4.2.47. `Changed_plant_item`

A `Changed_plant_item` is a type of `Change_item` (see 4.2.32) that identifies a `Plant_item` (see 4.2.260) that is being changed or is the result of a `Change` (see 4.2.30).

4.2.48. `Changed_plant_item_collection`

A `Changed_plant_item_collection` is a type of `Change_item` (see 4.2.32) that identifies a `Plant_item_collection` (see 4.2.262) that is being changed or is the result of a `Change` (see 4.2.30).

4.2.49. `Changed_plant_item_connection`

A `Changed_plant_item_connection` is a type of `Change_item` (see 4.2.32) that identifies a `Plant_item_connection` (see 4.2.263) that is being changed or is the result of a `Change` (see 4.2.30).

4.2.50. `Changed_plant_item_connector`

A `Changed_plant_item_connector` is a type of `Change_item` (see 4.2.32) that identifies a `Plant_item_connector` (see 4.2.265) that is being changed or is the result of a `Change` (see 4.2.30).

4.2.51. `Changed_plant_item_location`

A `Changed_plant_item_location` is a type of `Change_item` (see 4.2.32) that identifies a `Plant_item_location` (see 4.2.272) that is being changed or is the result of a `Change` (see 4.2.30).

4.2.52. `Changed_plant_item_shape`

A `Changed_plant_item_shape` is a type of `Change_item` (see 4.2.32) that identifies a `Plant_item_shape` (see 4.2.273) that is being changed or is the result of a `Change` (see 4.2.30).

4.2.53. `Changed_plant_process_capability`

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A **Changed_plant_process_capability** is a type of **Change_item** (see **4.2.32**) that identifies a **Plant_process_capability** (see **4.2.275**) that is being changed or is the result of a **Change** (see **4.2.30**).

4.2.54. Changed_plant_system

A **Changed_plant_system** is a type of **Change_item** (see **4.2.32**) that identifies a **Plant_system** (see **4.2.276**) that is being changed or is the result of a **Change** (see **4.2.30**).

4.2.55. Changed_reference_geometry

A **Changed_reference_geometry** is a type of **Change_item** (see **4.2.32**) that identifies a **Reference_geometry** (see **4.2.295**) that is being changed or is the result of a **Change** (see **4.2.30**).

4.2.56. Changed_required_material_description

A **Changed_required_material_description** is a type of **Change_item** (see **4.2.32**) that identifies a **Required_material_description** (see **4.2.299**) that is being changed or is the result of a **Change** (see **4.2.30**).

4.2.57. Changed_site

A **Changed_site** is a type of **Change_item** (see **4.2.32**) that identifies a **Site** (see **4.2.313**) that is being changed or is the result of a **Change** (see **4.2.30**).

4.2.58. Changed_site_feature

A **Changed_site_feature** is a type of **Change_item** (see **4.2.32**) that identifies a **Site_feature** (see **4.2.314**) that is being changed or is the result of a **Change** (see **4.2.30**).

4.2.59. Changed_sited_plant

A **Changed_sited_plant** is a type of **Change_item** (see **4.2.32**) that identifies a **Sited_plant** (see **4.2.316**) that is being changed or is the result of a **Change** (see **4.2.30**).

4.2.60. Changed_sub_plant_relationship

A **Changed_sub_plant_relationship** is a type of **Change_item** (see **4.2.32**) that identifies a **Sub_plant_relationship** (see **4.2.340**) that is being changed or is the result of a **Change** (see **4.2.30**).

4.2.61. Circular_ellipsoid

A **Circular_ellipsoid** is a type of **Csg_element** (see **4.2.84**) that has the following geometric characteristics: it is axial symmetric; cross sections taken in a plane normal to the axis result are circular; cross sections taken in plane containing the axis are elliptical; it is trimmed with a plane that is normal to an axis.

NOTE The shape of a Circular_ellipsoid may be described as a hemisphere that has been compressed along the circular axis.

4.2.62. Clamp

A Clamp is a set of devices used to join, grip, support, or compress mechanical or structural parts with opposing, often adjustable sides or parts for use in suspending pipe or for fastening hose to an end of pipe or fitting.

NOTE Figure 9 depicts a typical Pipe Clamp.

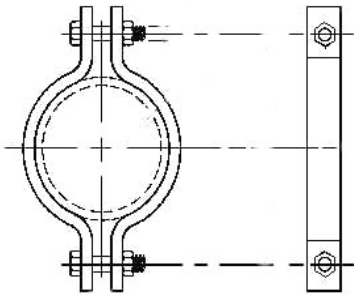


Figure 9 - Pipe Clamp

4.2.63. Clamped

A Clamped is a type of Piping_connector (see 4.2.242) that is a physical feature of a Plant_item (see 4.2.260) at which a Pipe Clamp (see 4.2.62) is attached.

4.2.64. Clamp_set

A Clamp_set is the collection of fasteners and items to be fully used with a Clamp (see 4.2.62).

The data associated with a Clamp_set are the following:

- set_id;
- quantity.

4.2.64.1 set_id

The set_id specifies a unique identifier for the Clamp_set. The set_id is required for each Clamp_set.

4.2.64.2 quantity

The quantity is the number of items in the Clamp_set.

4.2.65. Compound_bend_pipe

A Compound_bend_pipe is a type of Pipe (see 4.2.236) that is comprised of one or more of the following items grouped together and treated as a single Piping_component (see 4.2.240).

- Straight_pipe (see 4.2.332)
- Swept_bend_pipe (see 4.2.349)
- Mitre_bend_pipe (see 4.2.219)

The Compound_bend_pipe shall include at least one Swept_bend_pipe or Mitre_bend_pipe.

The relationship between the Compound_bend_pipe and its constituents shall be established using Connected_collection (see 4.2.70).

NOTE Figure 10 depicts a typical Compound_bend_pipe.

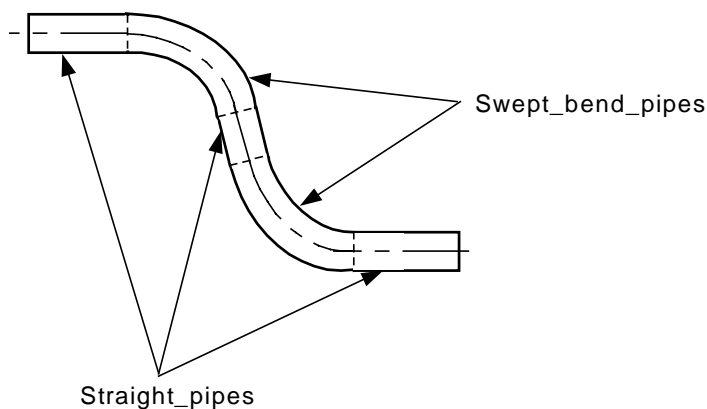


Figure 10 - Compound_bend_pipe

4.2.66. Conduit

A Conduit is a type of Cableway_piece (see 4.2.22) that is a tube with a round cross section that holds Cable (see 4.2.17) objects.

EXAMPLE Liquid-tight conduit, flexible conduit, rigid steel conduit, intermediate steel conduit, electrical metallic tubing, power concrete encased duct bank use conduit, rigid heavy wall conduit, rigid extra-heavy wall conduit.

4.2.67. Conduit_size_description

A Conduit_size_description is a type of Cableway_size_description (see 4.2.23) that is used to explain or summarize the physical size of a Conduit (see 4.2.66) based on a set of dimensional characteristics.

The data associated with a Conduit_size_description are the following:

- outer_diameter;
- inner_diameter;
- thickness.

4.2.67.1 outer_diameter

The `outer_diameter` specifies the external diameter of the Conduit (see **4.2.66**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.67.2 inner_diameter

The `inner_diameter` specifies the diameter of the opening of the Conduit (see **4.2.66**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.67.3 thickness

The `thickness` specifies the width of the wall of the Conduit (see **4.2.66**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.68. Cone

A Cone is a type of `Csg_element` (see **4.2.84**) that is a 3D volume with parallel, coaxial, circular cross-sections of radii that varies uniformly from a circular base to an axis normal to and positioned at the centre point of the base.

4.2.69. Conic

A Conic is a type of `Curve` (see **4.2.85**) composed of points located at a uniform distance from a point, a pair of points, or a point and a line.

EXAMPLE Kinds of Conics include circles, ellipses, parabolas, and hyperbolas.

4.2.70. Connected_collection

A `Connected_collection` is a type of `Plant_item_collection` (see **4.2.262**) where elements of the whole collection must be connected.

NOTE These connections may be identified explicitly by `Plant_item_connection` (see **4.2.263**) objects.

EXAMPLE A set of `Plant_item` (see **4.2.260**) objects can be collected for the purpose of defining the items that comprise an assembly. Examples of this assembly include packaged unit and module in a plant.

4.2.71. Connection_component

A `Connection_component` is a `Plant_item` (see **4.2.260**) that is used for the purpose of connecting other `Plant_items`.

4.2.72. Connection_definition

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A `Connection_definition` is a type of `Plant_item_connection` (see **4.2.263**) that specifies connection comprised of two or more connectors that is part of a `Plant_item_definition` (see **4.2.267**).

NOTE A `Connection_definition` that is part of a `Plant_item_definition` (see **4.2.267**) implies that the `Plant_item_definition` is a `Connected_collection` (see **4.2.70**).

4.2.73. Connection_inspection_record

A `Connection_inspection_record` is a collection of information that captures the result of an evaluation of an observed value for a characteristic of a connection against an expected or prescribed value for that characteristic, as well as information to evaluate the acceptability of the observed value.

The data associated with a `Connection_inspection_record` are the following:

- `inspected_property_name`;
- `connection_type`;
- `inspection_type`;
- `weld_id`;
- `connecting_portion_id`;
- `inspected_property_tolerance`;
- `inspected_property_measured_value`.

4.2.73.1 inspected_property_name

The `inspected_property_name` specifies the characteristic for which information is being recorded. The `inspected_property_name` may be one of the following:

For welded connections:

- `fit up`;
- `drift diameter tolerance`;
- `welding procedure`;
- `weld dimension`;
- `welding person`;
- `nde`;
- `heat treatment`;
- `hardness test`;

For flanged connections:

- `fit up`;
- `gasket type`;

- gasket thickness ;
- gasket compressed thickness;
- bolt and nut tightening torque.

For threaded connections:

- fit up;
- gasket type;
- gasket thickness;
- gasket compressed thickness;
- threaded tightening torque.

4.2.73.2 connection_type

The `connection_type` specifies the kind of connection that is being inspected. The `connection_type` may be one of the following:

- buttweld;
- slip on;
- socket;
- stub in;
- threaded;
- flanged.

4.2.73.3 inspection_type

The `inspection_type` specifies the kind of inspection that is being performed. The `inspection_type` may be one of the following:

- pt;
- mt;
- ut;
- rt;
- visual examination.

4.2.73.4 weld_id

The `weld_id` is an identification of the weld point at which the inspection is being made.

4.2.73.5 connecting_portion_id

The `connecting_portion_id` specifies a descriptive identification of the area of the connection that is being inspected.

EXAMPLE For a welded slip on flange connection, two connecting portions may be defined – the inner portion where the end of the pipe is welded to the inner surface of the fitting, and the outside portion where the end of the fitting is welded to the outside of the pipe.

4.2.73.6 inspected_property_tolerance

The `inspected_property_tolerance` specifies the acceptable deviation for the measured result of the inspection.

The inspected_property_measured_value specifies the recorded result of the inspection.

4.2.74. Connection_material

The Connection_material specifies the substances or other Plant_item (see 4.2.260) objects used at the connection of two Plant_item_connector (see 4.2.265) objects. This may be one or more specifications and one or more Plant_item objects.

EXAMPLE At a connection of two butt-weld connectors, there is a welding specification that applies to the connection. At a connection of two flanged connectors there are bolts and nuts that connect the Flanges (see 4.2.119), as well as a specification for the use of these items.

The data associated with a Connection_material are the following:

— material_name.

The material_name specifies common nomenclature used to refer to the material.

4.2.75. Connector_definition

A Connector_definition is a type of Plant_item_connector (see 4.2.265) that identifies the connector where a non-instantiated Plant_item (see 4.2.260) can connect to one or more other Plant_item_connector objects.

4.2.76. Coupling

A Coupling is a type of Fitting (see 4.2.117) that is used to make a linear connection between two pipes.

NOTE Figure 11 depicts a typical socket-weld Coupling.

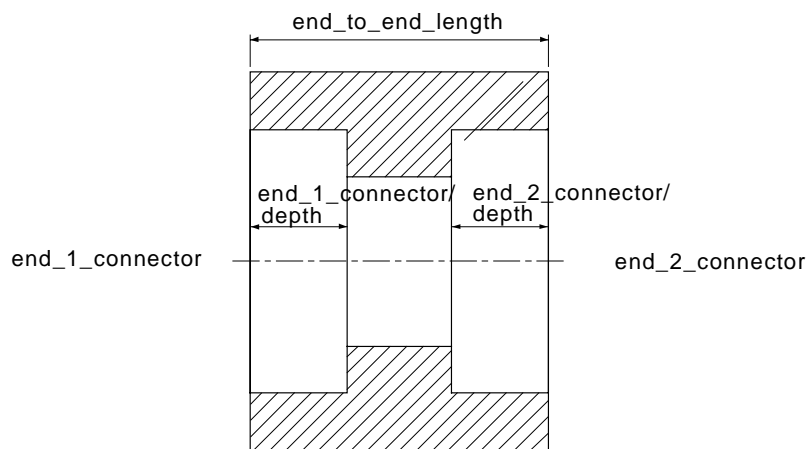


Figure 11- Socket weld Coupling

The data associated with a Coupling are the following:

- end_1_connector;
- end_2_connector;
- end_to_end_length.

4.2.76.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.242) designated as end one.

4.2.76.2 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.242) designated as end two.

4.2.76.3 end_to_end_length

The end_to_end_length specifies the external distance between the end-one and end-two faces. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.77. Cross

A Cross is a type of Fitting (see 4.2.117) that is a branched outlet consisting of four perpendicular legs to provide straight through and 90 degree flow.

NOTE Figure 12 depicts a typical butt-weld Cross.

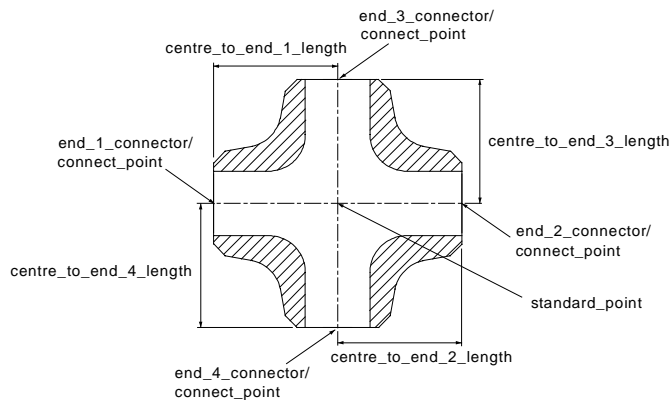


Figure 12 - Butt-weld Cross

The data associated with a Cross are the following:

- centre_to_end_1_length;
- centre_to_end_2_length;
- centre_to_end_3_length;
- centre_to_end_4_length;
- end_1_connector;

— end_2_connector;

— end_3_connector;

— end_4_connector.

4.2.77.1 centre_to_end_1_length

The `centre_to_end_1_length` specifies the distance from the intersection of the cross straight-run centreline and branch-run centreline to the end-one (straight-run) face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.77.2 centre_to_end_2_length

The `centre_to_end_2_length` specifies the distance from the intersection of the cross straight-run centreline and branch-run centreline to the end-two (straight-run) face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.77.3 centre_to_end_3_length

The `centre_to_end_3_length` specifies the distance from the intersection of the cross straight-run centreline and branch-run centreline to the end-three (branch-run) face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.77.4 centre_to_end_4_length

The `centre_to_end_4_length` specifies the distance from the intersection of the cross straight-run centreline and branch-run centreline to the end-four (branch-run) face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.77.5 end_1_connector

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end one.

4.2.77.6 end_2_connector

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end two.

4.2.77.7 end_3_connector

The `end_3_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end three.

4.2.77.8 end_4_connector

The end_4_connector specifies the Piping_connector (see 4.2.242) designated as end four.

4.2.78. Cross_section_flat_oval

A Cross_section_flat_oval is a type of Hvac_cross_section (see 4.2.150).

NOTE Figure 13 depicts a typical Cross_section_flat_oval.

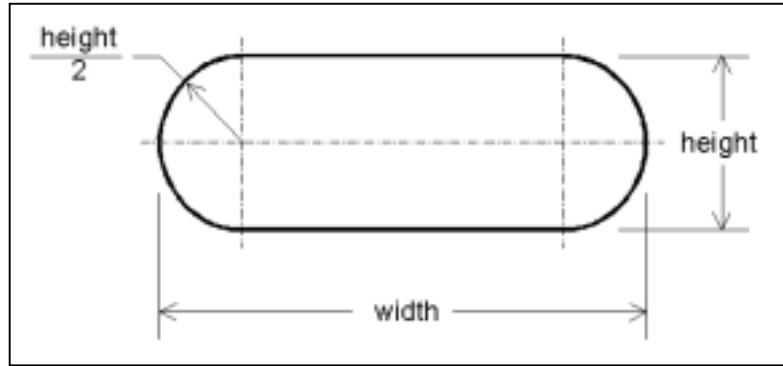


Figure 13 - Cross_section_flat_oval

The data associated with a Cross_section_flat_oval are the following:

- height;
- width.

4.2.78.1 height

This attribute specifies the distance between the flats as shown in Figure 13.

4.2.78.2 width

This attribute specifies the distance between the outside of the rounds as shown in Figure 13.

4.2.79. Cross_section_non_standard

The Cross_section_non_standard is a type of Hvac_cross_section (see 4.2.150) which cannot be defined by a set of common parameters and therefore requires explicit geometry to define the shape of the cross section.

The data associated with a Cross_section_non_standard are the following:

- cross_section_boundary.

A cross_section_boundary is a curve made up of several component curves but joined together to act as a single curve. The component curves are usually bounded by other surface intersections.

4.2.80. Cross_section_radiused_corner

The Cross_section_radiused_corner is a type of Hvac_cross_section (see 4.2.150) taken through a piece of rectangular duct whose corners are radiused.

NOTE Figure 14 depicts a typical Cross_section_radiused_corner.

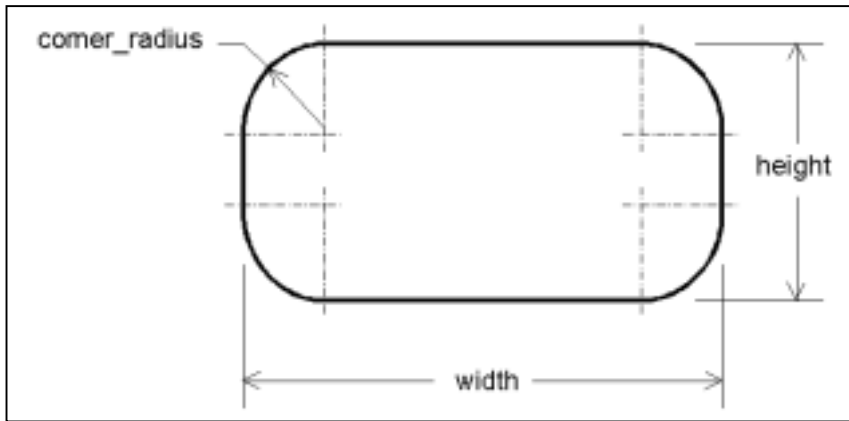


Figure 14 - Cross_section_radiused_corner

The data associated with a Cross_section_radiused_corner are the following:

- height;
- width;
- corner_radius.

4.2.80.1 height

This attribute specifies the distance between the horizontal flats as shown in Figure 14.

4.2.80.2 width

This attribute specifies the distance between the vertical flats as shown in Figure 14.

4.2.80.3 corner_radius

This attribute specifies the radius of the fillet between a vertical face and a horizontal face.

4.2.81. Cross_section_rectangular

The Cross_section_rectangular is a type of Hvac_cross_section (see **4.2.150**) applied to the cross section taken through a piece of rectangular duct in an hvac system.

The data associated with a Cross_section_rectangular are the following:

- height;
- width.

4.2.81.1 height

This attribute specifies the distance between the horizontal flats.

4.2.81.2 width

This attribute specifies the distance between the vertical flats.

4.2.82. Cross_section_round

The Cross_section_round is a type of Hvac_cross_section (see 4.2.150) which is applied to the cross section taken through a piece of round duct in an hvac system.

The data associated with a Cross_section_round are the following:

— radius.

This attribute specifies the distance from the centre of the cross section to a point on its circumference.

4.2.83. Cross_section_triangular

The Cross_section_triangular is a type of Hvac_cross_section (see 4.2.150) applied to the cross section taken through a piece of triangular duct in an hvac system.

The data associated with a Cross_section_triangular are the following:

— vertex_1;

— vertex_2;

— vertex_3.

4.2.83.1 vertex_1

Vertex_1 is a cartesian point which locates on of the three verticies of the triangular cross section. Vertex_1 is required for each Cross_section_triangular.

4.2.83.2 vertex_2

Vertex_2 is a cartesian point which locates on of the three verticies of the triangular cross section. Vertex_2 is required for each Cross_section_triangular.

4.2.83.3 vertex_3

Vertex_3 is a cartesian point which locates on of the three verticies of the triangular cross section. Vertex_3 is required for each Cross_section_triangular.

4.2.84. Csg_element

A Csg_element is a type of Shape_representation_element (see 4.2.310) that is a regular, 3D geometric shape that is combined with other regular shapes through boolean operations to create a complex, 3D, solid model. Each Csg_element is either: a Block (see 4.2.7), a Circular_ellipsoid (see 4.2.61), a Cone (see 4.2.68), a Cylinder (see 4.2.86), an Eccentric_cone (see 4.2.94), an Eccentric_cylinder (see 4.2.95), an Eccentric_pyramid (see 4.2.96), an Extrusion (see 4.2.111), a Faceted_brep (see 4.2.113), a Hemisphere (see 4.2.139), a Pyramid (see 4.2.288), a Reducing_torus (see 4.2.294), a Solid_of_revolution (see 4.2.321), a Sphere (see 4.2.326), a Square_to_round (see 4.2.329), a Torus (see 4.2.355), a Trimmed_block (see 4.2.357), a Trimmed_cone (see 4.2.358), a Trimmed_cylinder (see 4.2.359), a Trimmed_pyramid (see 4.2.360), a Trimmed_sphere (see 4.2.361), a Trimmed_torus (see 4.2.362).

4.2.85. Curve

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A Curve is a type of Wire_and_surface_element (see **4.2.372**) that is a one-dimensional manifold in a space of dimension two or three. A Curve may be a Conic (see **4.2.69**), a Free_form_curve (see **4.2.125**), a Line (see **4.2.196**), a Polygon (see **4.2.283**), or a Vector (see **4.2.368**).

NOTE Informally, a Curve can be envisioned as the path of a point moving in its coordinate space.

4.2.86. Cylinder

A Cylinder is a type of Csg_element (see **4.2.84**) that is a 3D cylindrical solid primitive with end surfaces that are planar and are perpendicular to the axis. The size and shape of a Cylinder is completely described by two real values that represent the radius and length of the cylinder.

4.2.87. Design_project

A Design_project is a task with a specifically defined purpose and scope that is used for the administration and management of plant designs.

The data associated with a Design_project are the following:

- description;
- name;
- owner.

4.2.87.1 description

The description specifies a textual explanation or summary of the Design_project.

4.2.87.2 name

The name specifies a textual label given to the Design_project.

4.2.87.3 owner

The owner specifies the name of the organization that is responsible for the Design_project.

4.2.88. Detail_shape

A Detail_shape is a type of Shape_representation (see **4.2.309**) that is the actual or intended external shape of a Plant_item (see **4.2.260**). A Detail_shape does not include the description of voids or other internal details of the shape of the Plant_item.

NOTE Contrast Detail_shape with Outline_shape (see **4.2.228**) and Envelope_shape (see **4.2.103**). A Detail_shape more closely approximates the actual shape of the Plant_item (see **4.2.260**) than either Envelope_shape or Outline_shape and is, therefore, likely to be more complex than either Envelope_shape or Outline_shape.

4.2.89. Document

A Document is the identification of a logical collection of information about a particular subject.

The data associated with a Document are the following:

- document_id;
- version_id;
- document_type;
- internal_document_reference.

4.2.89.1 document_id

The document_id specifies a unique identification for the Document.

4.2.89.2 version_id

The version_id specifies a unique identification of a revision of a particular Document.

4.2.89.3 document_type

The document_type specifies the kind of Document.

EXAMPLE A document_type may be “coating specification”, “material test report”, “mill sheet”, “positive material identification record”, “specification”, “record”, “chart”, etc.

4.2.89.4 internal_document_reference

The internal_document_reference specifies a specific location within a Document where information is represented.

4.2.90. Ducting_component

A Ducting_component is a type of Plant_item (see **4.2.260**) that conveys gaseous matter or airborne, particulate matter. Each Ducting_component may be one of the following: an Equipment_breaching (see **4.2.105**), an Hvac_ducting (see **4.2.151**), or a Process_ducting (see **4.2.286**).

EXAMPLE A Ducting_component that does not fall within one of the subtype categories may be cable trays, raceways, and other ducting used for routing and support of cables.

4.2.91. Ducting_system

A Ducting_system is a type of Plant_system (see **4.2.276**) that controls the temperature, humidity, cleanliness, and circulation of environmental or exhaust air as required in a Plant (see **4.2.258**). A Ducting_system may be an Hvac_system (see **4.2.176**).

The data associated with a Ducting_system are the following:

- type.

The type specifies a designation that classifies a Ducting_system based on the kind of service that it provides.

4.2.92. Dummy_leg

A Dummy_leg is a type of Piping_support (see 4.2.248) that is attached to a corner of bent part. The main body of it is usually a pipe but shape steel or plate is occasionally used as the material of the part. The Dummy_leg is placed horizontally and supports the weight that acts perpendicularly to the axis of the main body.

NOTE Figure 15 depicts a typical Dummy_leg.

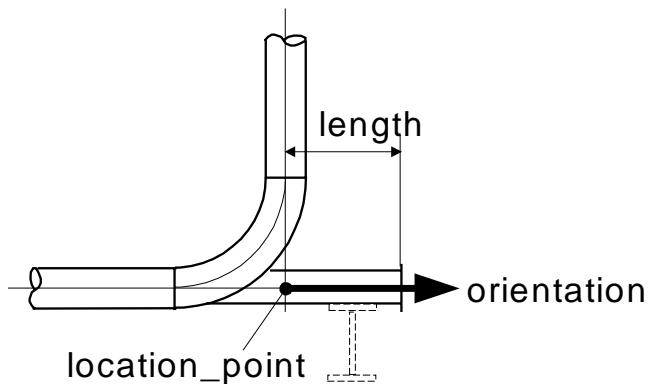


Figure 15 - Dummy_leg

The data associated with a Dummy_leg are the following:

— length.

The length specifies the distance between the end face of the Dummy_leg and the location_point.

4.2.93. Eccentric_base_elbow_support

An Eccentric_base_elbow_support is a type of Base_elbow_support (see 4.2.3) positioned such that its vertical leg is shifted from the centreline of the pipe it supports.

NOTE Figure 16 depicts a typical Eccentric_base_elbow_support.

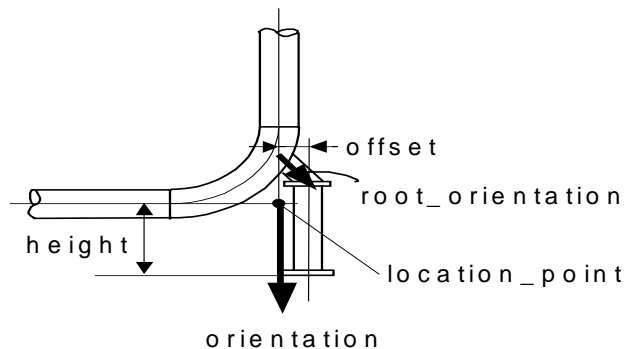


Figure 16 - Eccentric_base_elbow_support

The data associated with an Eccentric_base_elbow_support are the following:

- offset;
- root_orientation.

4.2.93.1 offset

The offset is the perpendicular distance between the location_point and the centreline of the main body of the Eccentric_base_elbow_support.

4.2.93.2 root_orientation

The root_orientation is the unit vector which gives the direction of the centreline of the inclined portion of the Eccentric_base_elbow_support at the point where it supports the pipe.

4.2.94. Eccentric_cone

An Eccentric_cone is a type of Csg_element (see 4.2.84) that consists of a Cone (see 4.2.68) with an axis that is not normal to the base.

4.2.95. Eccentric_cylinder

An Eccentric_cylinder is a type of Csg_element (see 4.2.84) that consists of a Cylinder (see 4.2.86) with an axis that is not normal to the base.

4.2.96. Eccentric_pyramid

An Eccentric_pyramid is a type of Csg_element (see 4.2.84) that consists of a Pyramid (see 4.2.288) with an axis that is not normal to the base.

4.2.97. Eccentric_reducer

An Eccentric_reducer is a type of Reducer (see 4.2.292) where the small end is off-centre from the large end.

NOTE Figure 17 depicts a typical butt-weld Eccentric_reducer. The end_<number>_connectors correspond to the end_<number>_connector attributes defined in Reducer (see 4.2.292).

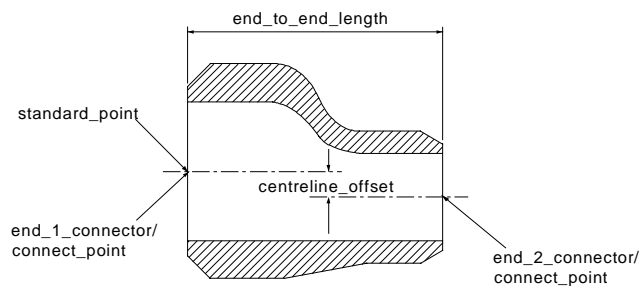


Figure 17 - Eccentric_reducer

The data associated with an Eccentric_reducer are the following:

- centreline_offset;
- flat_side_orientation.

4.2.97.1 centreline_offset

The centreline_offset specifies the perpendicular distance between the centreline of the large end of the Reducer (see 4.2.292) and the centreline of the smaller end of the Reducer.

4.2.97.2 flat_side_orientation

The flat_side_orientation specifies the direction of the straight side of the Eccentric_reducer.

NOTE 1 The direction of the straight side is typically specified as up or down.

NOTE 2 The straight side of the Eccentric_reducer corresponds to the side where the ends of the Eccentric_reducer have a common tangent point parallel to the centreline axes of the Eccentric_reducer.

NOTE 3 Eccentric swage is a synonym for Eccentric Reducer which is normally used for smaller sizes.

4.2.98. Elbow

An Elbow is a type of Fitting (see 4.2.117) that is used to change the direction of piping.

NOTE Figure 18 depicts a typical socket-weld Elbow.

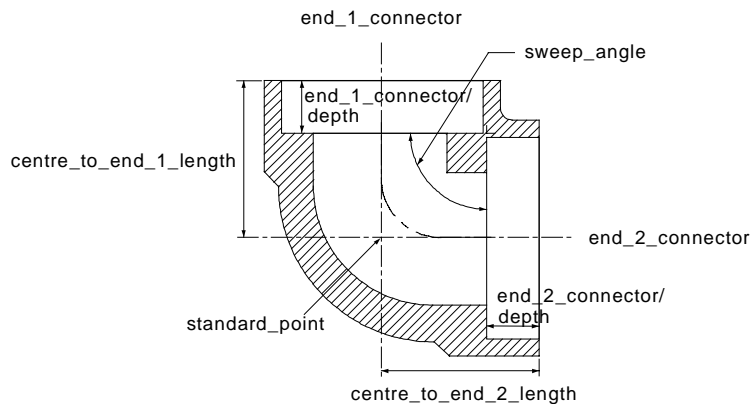


Figure 18 - Elbow

The data associated with an Elbow are the following:

- centre_to_end_1_length;
- centre_to_end_2_length;
- centreline_radius;
- end_1_connector;

- end_2_connector;
- sweep_angle;
- type.

4.2.98.1 centre_to_end_1_length

The `centre_to_end_1_length` specifies the distance from the centre of the Elbow (i.e., where the centrelines for the two ends intersect) to the end-one face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.98.2 centre_to_end_2_length

The `centre_to_end_2_length` specifies the distance from the centre of the Elbow (i.e., where the centrelines for the two ends intersect) to the end-two face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.98.3 centreline_radius

The `centreline_radius` specifies the distance from the centreline of the Elbow to the intersection of the perpendicular projection of the centreline taken at the point where the Elbow centreline ends or where the inlet and outlet ends of the Elbow centreline become straight lines. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.98.4 end_1_connector

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end one.

4.2.98.5 end_2_connector

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end two.

4.2.98.6 sweep_angle

The `sweep_angle` specifies the included angle formed between two lines that are parallel to the end-one and end-two faces of the Elbow, measured at their point of intersection (the centre of radius of the Elbow). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.98.7 type

The `type` specifies a designation that classifies the Elbow.

EXAMPLE Examples of elbow designations include long radius, short radius, reducing, and street.

4.2.99. Electrical_component

An `Electrical_component` is a type of `Plant_item` (see **4.2.260**) that is an individually identifiable and functional part of an `Electrical_system` (see **4.2.101**).

EXAMPLE Examples of `Electrical_components` include cable tray, wireway, conduit, ductbank, cables, switches, relays, motor control centres, and junction boxes.

4.2.100. `Electrical_connector`

An `Electrical_connector` is a type of `Plant_item_connector` (see **4.2.265**) that is intended to establish an electrical connection (signal or power) between two `Plant_item` (see **4.2.260**) objects.

The data associated with an `Electrical_connector` are the following:

— type.

The type specifies the designation that describes the functional behaviour of the `Electrical_connector`.

4.2.101. `Electrical_system`

An `Electrical_system` is a type of `Plant_system` (see **4.2.276**) that is a system of wiring, switches, relays, and other equipment associated with receiving and distributing electrical power.

The data associated with an `Electrical_system` are the following:

— `system_voltage_designation`;

— type.

4.2.101.1 `system_voltage_designation`

The `system_voltage_designation` is the rated voltage of the system.

4.2.101.2 type

The type specifies a designation that classifies the `Electrical_system` based on the kind of service that it provides.

4.2.102. `Electricity_transference`

An `Electricity_transference` is a type of `Plant_item_connection` (see **4.2.263**) that identifies the purpose or role of the connection as being the transfer of electrical current or signal.

4.2.103. `Envelope_shape`

An `Envelope_shape` is a type of `Shape_representation` (see **4.2.309**) that is a 3D spatial volume that completely encloses or bounds a `Plant_item` (see **4.2.260**). An `Envelope_shape` is a very simple geometric shape, such as a box, that encloses the plant item. An `Envelope_shape` may, but need not, include clearance or access spaces associated with the plant item.

NOTE Contrast Envelope_shape with Detail_shape (see 4.2.88) and Outline_shape (see 4.2.228).

4.2.104. Equipment

An Equipment is a type of Plant_item (see 4.2.260) that is treated as a single and self-contained unit that provides a function. Each Equipment may be an Inline_equipment (see 4.2.182).

The data associated with an Equipment are the following:

- characteristics;
- equipment_type;
- heat_tracing_type;
- insulation_specification;
- rated_temperature;
- shock_qualification_status;
- vibration_amplitude;
- vibration_frequency.

4.2.104.1 characteristics

The characteristics specifies functional attributes of the Equipment.

EXAMPLE Characteristics of a pump may be that it operates at 80% efficiency while pumping 1250 gallons per minute.

4.2.104.2 equipment_type

The equipment_type specifies a classification of an Equipment based on its performance characteristics.

EXAMPLE Examples of equipment_type classifications include compressor, engine, furnace, gear box, heat exchanger, pressure vessel, pump, silo, tank, and turbine.

4.2.104.3 heat_tracing_type

The heat_tracing_type specifies the means utilized to impart a temperature increase to the Equipment by an external wrapping or coiling.

EXAMPLE Examples of heat_tracing_types include, but are not limited to, electrical or steam.

4.2.104.4 insulation_specification

The insulation_specification specifies the document that defines the insulation requirements for the Equipment.

4.2.104.5 rated_temperature

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The rated_temperature applies to the maximum temperature of the environment where the operating equipment will be installed.

4.2.104.6 shock_qualification_status

The shock_qualification_status for hvac applications falls into an "A" or "B" category. Under category "A" an hvac component can withstand the full limits of shock and still operate. Under the "B" category the hvac component will not be operational after full shock but the component will remain intact.

4.2.104.7 vibration_amplitude

The vibration_amplitude is the magnitude, or amount, of displacement, velocity, or acceleration, measured from the "at rest" value. The amplitude of a vibration signal can be expressed in terms of "peak" level, "Peak-to-peak" level, or RMS level. It is somewhat of a de facto standard that Displacement is peak-to-peak, Velocity is peak, and Acceleration is RMS.

4.2.104.8 vibration_frequency

Vibration_frequency refers to the pitch of a sound generated by vibration within an hvac system. Usually measured in cycles per second (cps).

4.2.105. Equipment_breaching

An Equipment_breaching is a type of Ducting_component (see **4.2.90**) consisting of a type of ductwork connected to a piece of Equipment (see **4.2.104**) for the purpose of exhausting gases.

4.2.106. Equipment_trim_piping

An Equipment_trim_piping is piping connected to a piece of Equipment (see **4.2.104**) that performs a function integral to the Equipment.

NOTE The piping is normally designed and possibly provided or installed by the Equipment manufacturer. Piping of this nature is normally of nominal size two inches and below.

4.2.107. Expander_flange

An Expander_flange is a type of Flange (see **4.2.119**) that provides a transition from a smaller to a larger diameter Pipe (see **4.2.236**) at a flanged connection.

NOTE Figure 19 depicts a typical Expander_flange.

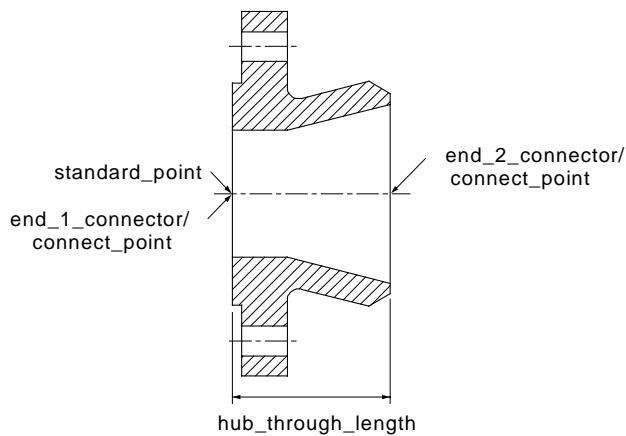


Figure 19 - Expander flange

4.2.108. External_classification

An External_classification is a designation and description that classifies a Plant_item (see 4.2.260), Plant (see 4.2.258), Plant_system (see 4.2.276), or Plant_item_connector (see 4.2.265) based on predefined tables or sources defined externally to this part. The designation is a reference to the predefined table or source.

The data associated with an External_classification are the following:

- description;
- name;
- source.

4.2.108.1 description

The description specifies a textual explanation or summary of the External_classification.

4.2.108.2 name

The name specifies a textual label given to the External_classification.

4.2.108.3 source

The source specifies a designation that identifies a table or document that contains a list of candidate classifications that the name and description are drawn from.

4.2.109. Externally_defined_document

An externally_defined_document is a Document (see 4.2.89) that is referenced from a source outside the context of an exchange.

The data associated with an Externally_defined_document are the following:

- source_id;

— source_description.

4.2.109.1 source_id

The source_id specifies a unique identification of the external origin of the document.

EXAMPLE A source_id may be “ANSI”, “ISO”, “ISO 13584”, “DIN”, “JIS”, “PFI”, “Joe’s notebook” or another external source.

4.2.109.2 source_description

The source_description is text that characterizes the external_source.

4.2.110. Externally_defined_user_defined_attribute_value

An Externally_defined_user_defined_attribute_value is a type of User_defined_attribute_value (see **4.2.366**).

The data associated with an Externally_defined_user_defined_attribute_value are the following:

— source;

The source specifies a textual identification of the reference resource in which the User_defined_attribute_value is described.

4.2.111. Extrusion

An Extrusion is a type of Csg_element (see **4.2.84**) that is a closed, 2D profile swept through a linear distance in space.

4.2.112. Facet_trigon

A Facet_trigon is a planar, polygonal surface with three sides.

NOTE In 3D computer models, curved surfaces are sometimes represented by a collection of Facets that approximate the curved surface.

4.2.113. Faceted_brep

A Facet_brep is a type of Csg_element (see **4.2.84**).

4.2.114. Faceted_surface_representation

A Faceted_surface_representation is a type of Site_shape_representation (see **4.2.315**) that consists of a collection of Facet_trigon (see **4.2.112**) objects that represent the topography of a Site (see **4.2.313**).

4.2.115. Family_definition

A **Family_definition** is a **Plant_item_definition** (see 4.2.267) that characterizes a set of **Piping_component** (see 4.2.240) objects based on common physical characteristics. Physical characteristics may be specified as a specific value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

EXAMPLE A **Piping_specification** (see 4.2.245) describes a **Family_definition**, such as a class of elbows made of stainless steel that are long radius elbows between six inches and twenty four inches in diameter.

The data associated with a **Family_definition** are the following:

— **family_classification_description**.

The **family_classification_description** specifies a textual explanation of the principle characteristics that vary within the family.

4.2.116. Female_end

A **Female_end** is a type of **Piping_connector** (see 4.2.242) end type that forms a recessed opening at the connector to support the insertion of a compatible male connector.

NOTE Figure 20 depicts a typical **Female_end**.

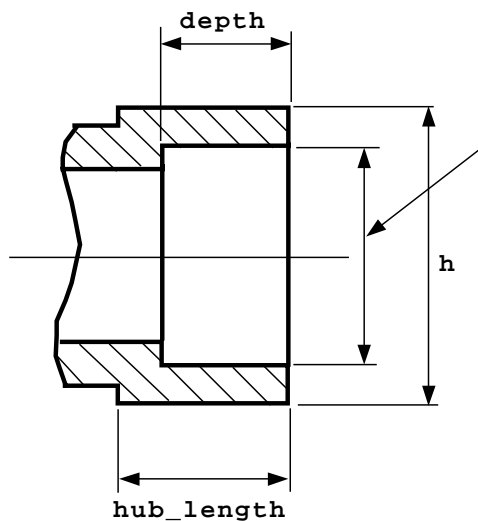


Figure 20 - Female_end

The data associated with a **Female_end** are the following:

— **depth**;

— **hub_inside_diameter**;

— **hub_length**;

— **hub_outside_diameter**.

4.2.116.1 depth

The depth specifies the distance from the face of the Piping_connector (see 4.2.242) to the depth of relief. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.116.2 hub_inside_diameter

The hub_inside_diameter specifies the diameter of the opening at the hub. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.116.3 hub_length

The hub_length specifies the distance from the face of the Plant_item_connector (see 4.2.265) to the point where the hub size transitions to the body size of the Plant_item (see 4.2.260). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.116.4 hub_outside_diameter

The hub_outside_diameter specifies the external diameter of the hub. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.117. Ferrule

A Ferrule is a metal cylinder placed over a hose end to affix the fitting to the hose.

NOTE Figure 21 depicts a typical Ferrule.

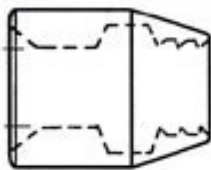


Figure 21 - Ferrule

The data associated with a Ferrule are the following:

- end_1_connector;
- end_2_connector;
- length.

4.2.117.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.242) designated as end one.

4.2.117.2 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.242) designated as end two.

4.2.117.3 length

The length is the distance between the end_1_connector and the end_2_connector.

4.2.118. Fitting

A Fitting is a type of Piping_component (see 4.2.240) used to join or terminate sections of Pipe (see 4.2.236) or provide changes of direction or branching in a Piping_system (see 4.2.249). Each Fitting may be one of the following: a Blank (see 4.2.5), a Bushing (see 4.2.15), a Coupling (see 4.2.76), a Cross (see 4.2.77), an Elbow (see 4.2.98), a Flange (see 4.2.119), an Insert (see 4.2.184), a Lap_joint_stub_end (see 4.2.194), a Lateral (see 4.2.195), an Olet (see 4.2.225), an Orifice_plate (see 4.2.227), a Pipe_closure (see 4.2.237), a Reducer (see 4.2.292), a Spacer (see 4.2.322), a Tee (see 4.2.351), a Union (see 4.2.364), or a Y_type_lateral (see 4.2.373).

4.2.119. Flange

A Flange is a type of Fitting (see 4.2.117) that is an annular collar that permits a bolted connection to a similar collar. Each Flange contains two end connectors, one of which shall be a Piping_connector (see 4.2.242) of type Flanged_end. Each Flange may be one of the following: a Blind_flange (see 4.2.6), an Expander_flange (see 4.2.107), an Orifice_flange (see 4.2.226), or a Reducing_flange (see 4.2.293). Each Flange may be one of the following: a Lap_joint_flange (see 4.2.193), a Slip_on_flange (see 4.2.317), a Socket_weld_flange (see 4.2.320), a Threaded_flange (see 4.2.353), or a Weld_neck_flange (see 4.2.370).

The data associated with a Flange are the following:

- end_1_connector;
- end_2_connector;
- hole_straddle_centreline_orientation;
- hub_through_length;
- hub_weld_point_diameter.

4.2.119.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.242) at the flange face.

4.2.119.2 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.242) at the hub face.

4.2.119.3 hole_straddle_centrelines_orientation

The hole_straddle_centrelines_orientation is the orientation of the hole straddle centreline of the Flange in plant coordinates. The hole straddle centreline is the line on the flange surface connected between the centre of the Flange and the middle point of two neighboring bolt holes.

NOTE Figure 22 depicts hole_straddle_centrelines_orientation.

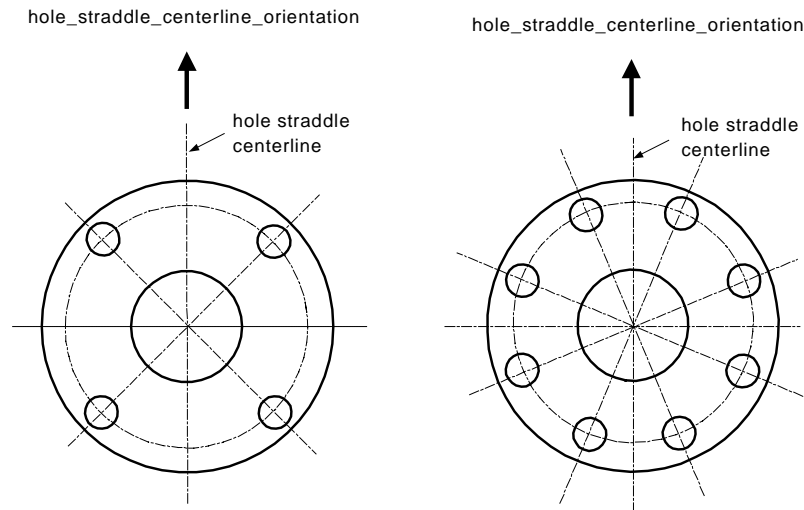


Figure 22 - Hole_straddle_centrelines_orientation

NOTE The receiving system may transform the plant coordinates into a local coordinate system if necessary.

4.2.119.4 hub_through_length

The hub_through_length specifies the distance between the flange face and the hub face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.119.5 hub_weld_point_diameter

The hub_weld_point_diameter specifies the outside diameter of the hub at the point of connection between the flange and the pipe. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.120. Flanged

A Flanged is a type of Piping_connector (see 4.2.242) end engagement type consisting of a circular disk of material with holes around the circumference and a facing style.

NOTE The holes are used to bolt together two connected flanges. The facing is the mating surface that in conjunction with a gasket forms a tight connection by the pressure of the two connected flanged connectors. A flanged connection can be disassembled.

4.2.121. Flanged_end

A Flanged_end is a type of Piping_connector (see 4.2.242) end type that is a circular disk of material that supports the insertion of bolts to mate with a compatible Flanged_end.

NOTE Figure 23 depicts a typical Flanged_end.

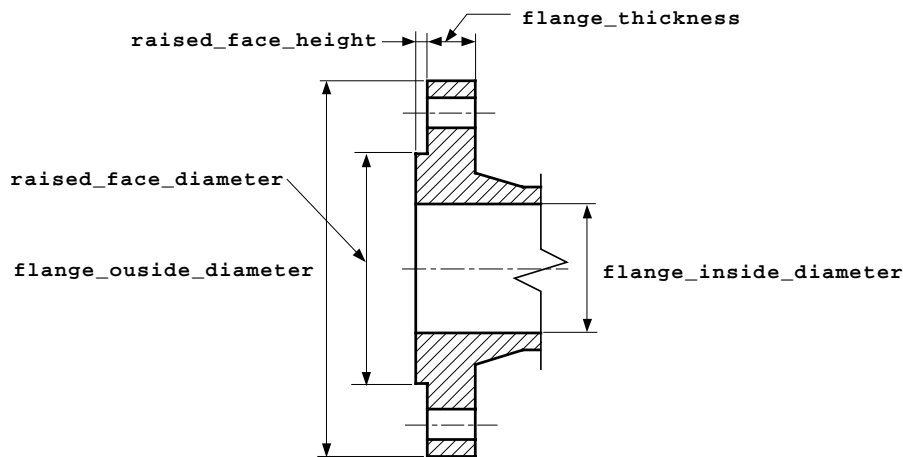


Figure 23 - Flanged_end

The data associated with a Flanged_end are the following:

- face_finish;
- face_type;
- flange_inside_diameter;
- flange_outside_diameter;
- flange_thickness;
- raised_face_diameter;
- raised_face_height;
- ring_bottom_radius;
- ring_diameter;
- ring_width.

4.2.121.1 face_finish

The face_finish specifies a description of the Flange (see 4.2.119) face surface roughness and groove pattern.

4.2.121.2 face_type

The face_type specifies a classification of the mating surface of a Flange (see 4.2.119) based on its shape characteristics.

EXAMPLE Examples of face_type designations include raised_face, flat_face, ring_type_joint, male_face_of_male_and_female, female_face_of_male_and_female, male_face_of_tongue_and_groove, and female_face_of_tongue_and_groove.

NOTE Figures 24 to 28 depict these face types.

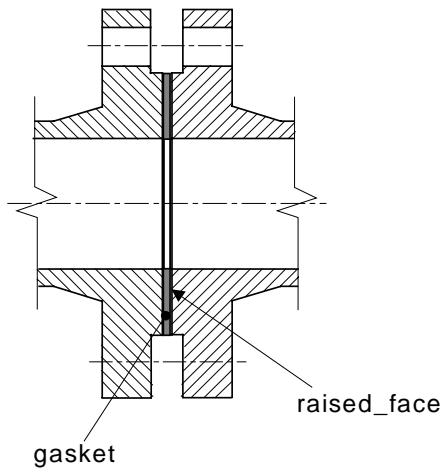


Figure 24 - Raised face flange

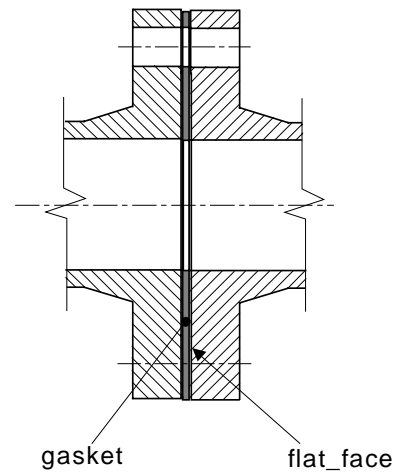


Figure 25 – Flat face flange

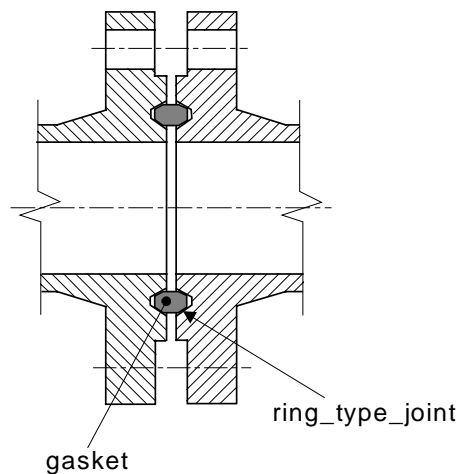


Figure 26 - Ring type joint flange

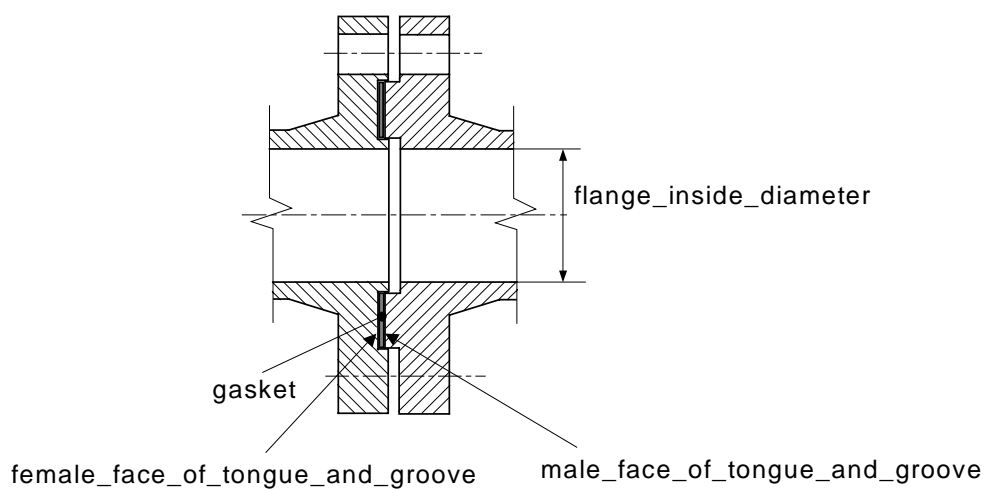


Figure 27 - Male and female flange

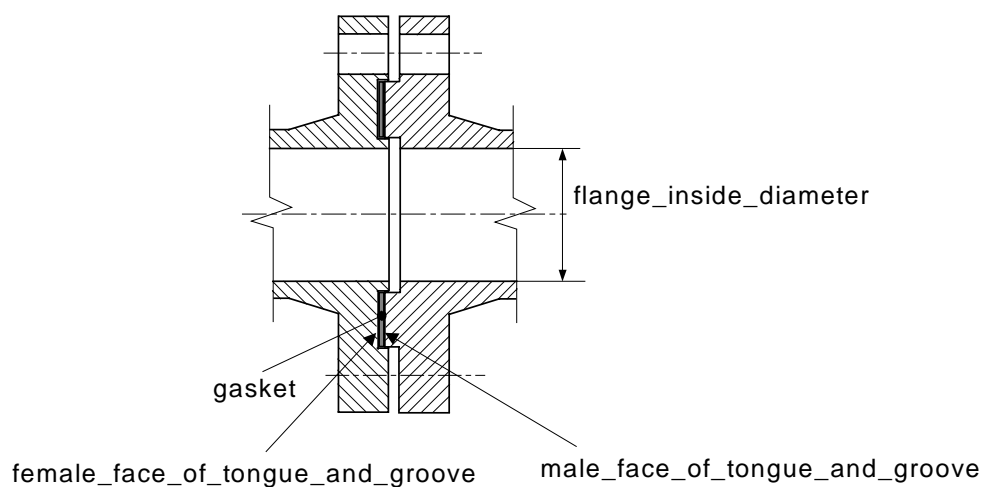


Figure 28 - Tongue and groove flange

4.2.121.3 flange_inside_diameter

The flange_inside_diameter specifies the interior diameter of the Flange (see 4.2.119) at the working point. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.121.4 flange_outside_diameter

The `flange_outside_diameter` specifies the external diameter of the Flange (see **4.2.119**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.121.5 flange_thickness

The `flange_thickness` specifies the distance between the inside and outside Flange (see **4.2.119**) disk surfaces, measured at the disk perimeter. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.121.6 raised_face_diameter

The `raised_face_diameter` specifies the diameter measured across the elevated portion of the mating surface of a Flange (see **4.2.119**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.121.7 raised_face_height

The `raised_face_height` specifies the perpendicular distance measured from the elevated portion of the Flange (see **4.2.119**) mating surface to the lower Flange surface. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.121.8 ring_bottom_radius

The `ring_bottom_radius` specifies the radial measure of the bottom corners of a ring in raised face. The `ring_bottom_radius` may not be specified for a particular `Flanged_end`, but when specified must be accompanied by `raised_face_diameter`, `raised_face_height`, `ring_diameter`, and `ring_width`.

4.2.121.9 ring_diameter

The `ring_diameter` specifies the diameter of a ring in the raised-face portion of a `Flanged_end`. The `ring_diameter` may not be specified for a particular `Flanged_end`, but when specified must be accompanied by `raised_face_diameter`, `raised_face_height`, `ring_bottom_radius`, and `ring_width`.

4.2.121.10 ring_width

The `ring_width` specifies the width of the groove formed by a ring in the raised-face portion of a `Flanged_end`. The `ring_width` may not be specified for a particular `Flanged_end`, but when specified must be accompanied by `raised_face_diameter`, `raised_face_height`, `ring_bottom_radius`, and `ring_diameter`.

4.2.122. Flared_end

A Flared_end is an end_type where the inside_diameter and outside_diameter at the end is increased with no change in thickness forming a kind of lip.

The data associated with a Flared_end are the following:

- diameter;
- thickness.

4.2.122.1 diameter

The diameter is the inside diameter at the end of the flare (largest point).

4.2.121.2 thickness

The thickness is the Fitting (see 4.2.118) thickness at the point the diameter is measured.

4.2.123. Flexible_connection

A Flexible_connection is a type of Plant_item_connection (see 4.2.263) in which two Plant_item_connector (see 4.2.265) objects are in physical contact, though there is no implication concerning the freedom of motion of the connected Plant_item (see 4.2.260) objects.

EXAMPLE The pump driver may be connected to an electrical cable at its terminal using a Flexible_connection; the cable need not rotate when the pump is rotated, but contact must be preserved.

4.2.124. Fluid_transference

A Fluid_transference is a type of Plant_item_connection (see 4.2.263) that identifies the purpose or role of the connection as being the transfer of gas, vapour, liquid or solid material.

4.2.125. Free_form_curve

A Free_form_curve is a type of Curve (see 4.2.85). It is a one-dimensional, contiguous set of points.

4.2.126. Functional_connection_definition_satisfaction

A Functional_connection_definition_satisfaction is the assignment of an actual Connection_definition (see 4.2.72) to a functional Connection_definition for the purpose of satisfying the functional requirements with a physical object.

The data associated with a Functional_connection_definition_satisfaction are the following:

- functional_connection_definition;
- physical_connection_definition.

4.2.126.1 functional_connection_definition

The `functional_connection_definition` is a reference to the `connection_id` of the `Connection_definition` (see 4.2.72) object that describes the functional view of the connection.

4.2.126.2 physical_connection_definition

The `physical_connection_definition` is a reference to the `connection_id` of the `Connection_definition` object that describes the physical view of the connection that satisfies the function specified by the functional view of the definition of the connection.

4.2.127. Functional_connection_occurrence_satisfaction

A `Functional_connection_occurrence_satisfaction` is the assignment of an actual `Plant_item_connection_occurrence` (see 4.2.264) to a functional `Plant_item_connection_occurrence` for the purpose of satisfying the functional requirements with a physical object. The data associated with a `Functional_connection_occurrence_satisfaction` are the following:

— `physical_connection`.

The `physical_connection` is a reference to the `connection_id` of the occurrence of the connection that describes the physical view of the connection that satisfies the function specified by the functional view of the occurrence of the connection.

4.2.128. Functional_connector

A `Functional_connector` is a type of `Plant_item_connector_occurrence` (see 4.2.266) that represents the functional or logical aspect of the `Plant_item_connector_occurrence`. Each `Functional_connector` is either: a `Line_plant_item_branch_connector` (see 4.2.202) or a `Line_plant_item_connector` (see 4.2.204).

4.2.129. Functional_connector_definition_satisfaction

A `Functional_connector_definition_satisfaction` is the assignment of an actual `Connector_definition` (see 4.2.75) to a functional `Connector_definition` for the purpose of satisfying the functional requirements with a physical object.

4.2.130. Functional_connector_occurrence_satisfaction

A `Functional_connector_occurrence_satisfaction` is the assignment of an actual `Physical_connector` (see 4.2.234) to a `Functional_connector` (see 4.2.128) for the purpose of satisfying the functional requirements with a physical object.

4.2.131. Functional_design_view

A `Functional_design_view` is a type of `Plant_item_design_view` (see 4.2.268) that indicates that data associated with the `Plant_item` (see 4.2.260) are the logical characteristics of a `Plant_item` rather than the physical.

The data associated with a `Functional_design_view` are the following:

- `tag_number`.

The `tag_number` specifies an optional identifier assigned to the `Plant_item` (see 4.2.260) for purposes of functional identification and eventual physical tracking.

4.2.132. Functional_plant

A `Functional_plant` is a `Plant` (see 4.2.258) that is the identification of a view of the `Plant` that aggregates the functional characteristics of the `Plant`.

4.2.133. Functional_plant_item_satisfaction

A `Functional_plant_item_satisfaction` is the assignment of a `Physical_design_view` (see 4.2.235) to a `Functional_design_view` (see 4.2.131) for the purpose of satisfying the functional requirements with a physical object.

4.2.134. Functional_plant_satisfaction

A `Functional_plant_satisfaction` is the assignment of an actual `Planned_physical_plant` (see 4.2.256) to a `Functional_plant` (see 4.2.132) for the purpose of satisfying the functional requirements with a physical object.

The data associated with a `Functional_plant_satisfaction` are the following:

- `functional_plant`;

- `planned_physical`.

4.2.134.1 functional_plant

The `functional_connection_definition` is a reference to the `plant_id` of the `Functional_plant` object that describes the functional view of the connection.

4.2.134.2 planned_physical

The `planned_physical` is a reference to the `plant_id` of the `Planned_physical_plant` object that describes the physical view of the plant that satisfies the function specified by the functional view of the plant.

4.2.135. Gasket

A `Gasket` is a type of `Piping_component` (see 4.2.240) that seals a connection between two connectors.

NOTE Gaskets are primarily used with Flanged (see 4.2.120) `Plant_item_connector` (see 4.2.265).

The data associated with a `Gasket` are the following:

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— compressed_thickness;

— uncompressed_thickness.

4.2.135.1 compressed_thickness

The compressed_thickness specifies the distance between the two parallel surfaces of the Gasket in its compressed state in a connection. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.135.2 uncompressed_thickness

The uncompressed_thickness specifies the as-procured distance between the two parallel surfaces of the Gasket. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.136. Gis_position

A Gis_position is the positioning and orientation information necessary for transforming coordinate values between a local coordinate space and the global coordinate system of earth. Transformation procedures depend upon the geographic information system (GIS) coordinate system. Each Gis_position object designates the global position and orientation of a Site_shape_-representation (see 4.2.315).

The data associated with a Gis_position are the following:

— height;

— scale;

— system;

— x_axis_delta_x;

— x_axis_delta_y;

— x_coordinate;

— y_coordinate;

— zone.

4.2.136.1 height

The height specifies the distance above sea level or reference level in the GIS coordinate system.

4.2.136.2 scale

The scale specifies a transformation factor applied to the conversion of point coordinates between a local coordinate system and a GIS coordinate system. The precise application of the transformation will depend on the GIS system.

4.2.136.3 system

The system specifies the identifier of the GIS system being used.

EXAMPLE Gauss-Krueger, Universal Transverse Mercator (UTM), and State Plane are examples of GIS systems used for global positioning.

4.2.136.4 x_axis_delta_x

The x_axis_delta_x specifies the abscissa value of the end point of a vector indicating the positive x-axis of GIS coordinate space in the local coordinate system.

4.2.136.5 x_axis_delta_y

The x_axis_delta_y specifies the ordinate value of the end point of a vector indicating the orientation or the positive x-axis of GIS coordinate space in the local coordinate system.

EXAMPLE The GIS coordinate system XY00 has an origin at the intersection of the equator and the Greenwich meridian. The x-axis of the coordinate system runs East (positive) and West (negative). The y-axis runs North (positive) and South (negative). The positive z-axis is up (above sea level or the reference level in the GIS coordinate system). The negative z-axis is down (below sea level or the reference level in the GIS coordinate system). An x_axis_delta_x of 1.0 and x_axis_delta_y of 1.0 indicates x axis of the GIS coordinate space makes a +45° angle with respect to the x axis of the local coordinate; if the local coordinate space were superimposed on the GIS coordinate space, the positive x-axis of the local coordinate system would point in a South-East direction (-45°).

4.2.136.6 x_coordinate

The x_coordinate specifies the distance from the y-axis of the coordinate space defined by the GIS system and zone.

4.2.136.7 y_coordinate

The y_coordinate specifies the distance from the x-axis of the coordinate space defined by the GIS system and zone.

The zone specifies a subdivision of the earth's surface based on the GIS system.

EXAMPLE The Gauss-Krueger GIS system subdivides the earth into 120 zones that are 3° in longitudinal width. Each zone is identified as 3°, 6°, 9°, etc., from the Greenwich meridian.

4.2.137. Grooved_end

A Grooved_end is a type of Piping_connector (see **4.2.242**) end type that contains a circumferential groove cut or is rolled on a pipe surface for a grooved joint connection.

NOTE Figure 29 depicts a typical Grooved_end.

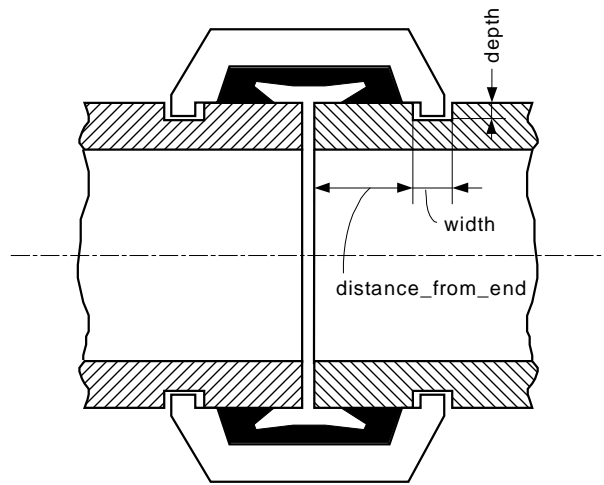


Figure 29 - Grooved_end

The data associated with a Grooved_end are the following:

- depth;
- distance_from_end;
- width.

4.2.137.1 depth

The depth specifies the distance between the outer surface of the Pipe (see **4.2.236**) and the bottom of the groove. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.137.2 distance_from_end

The distance_from_end specifies the distance between the end of the Pipe (see **4.2.236**) and the inner edge of the groove. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.137.3 width

The width specifies the distance between the inner edge and the outer edge of the groove. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.138. Gusset

A Gusset is a type of Reinforcing_component (see 4.2.296) that is a tensile member placed diagonally between run pipe and branch pipe, and prevents the branch from breaking or deforming.

NOTE Figure 30 depicts a Gusset.

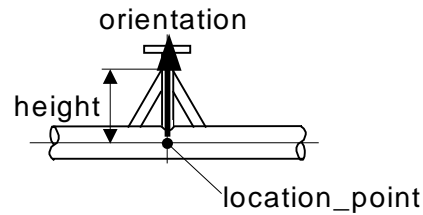


Figure 30 - Gusset

The data associated with a Gusset are the following:

— height.

The height is the distance between the location point and the most outer point of the Gusset welded to the branch pipe. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.139. Hemisphere

A Hemisphere is a type of Csg_element (see 4.2.84) that is formed by cutting a Sphere (see 4.2.326) with a plane that passes through the centre point of the Sphere and removing one section.

4.2.140. Hexagon_head_bolt

A Hexagon_head_bolt is a type of a Bolt (see 4.2.8) that has a hexagonal head at one end and a screw thread on the other.

The data associated with a Hexagon_head_bolt are the following:

— length.

The length specifies the distance from the inner face of the hexagonal head to the tip of the screw thread. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.141. Hierarchically_organized_collection

A Hierarchically_organized_collection is a type of Plant_item_collection (see 4.2.262) that indicates whether a Plant_item (see 4.2.260) that is a member of an aggregate Plant_item is related to other Plant_items that are also members of the aggregate Plant_item. The members of the aggregate may, but need not, be connected.

4.2.142. Hvac_access_opening

ISO/CD 10303-227

An `Hvac_access_opening` is a hole in an `Hvac_component` (see **4.2.145**) providing maintenance access.

The data associated with an `Hvac_access_opening` are the following:

- `access_opening_id`;
- `access_type`;
- `shape`.

4.2.142.1 access_opening_id

This attribute differentiates one `Hvac_access_opening` on an `Hvac_component` (see **4.2.145**) from another.

4.2.142.2 access_type

This attribute specifies the type of opening in the `Hvac_component` (see **4.2.145**).

4.2.142.3 shape

The `shape` is the volumetric representation of the `Hvac_access_opening` or the projection of the `Hvac_access_opening` on the `Hvac_component` (see **4.2.145**).

4.2.143. Hvac_bend

An `Hvac_bend` is an `Hvac_fitting` (see **4.2.157**) which follows a curved path. The cross section of the fitting is normal to the path.

The data associated with an `Hvac_bend` are the following:

- `bend_path`;
- `end_1_connector`;
- `end_2_connector`;
- `length`.

4.2.143.1 bend_path

The `bend_path` is the centreline trace of the `Hvac_bend`.

4.2.143.2 end_1_connector

The `end_1_connector` is the primary connecting end of an `Hvac_bend`.

4.2.143.3 end_2_connector

The end_2_connector is the secondary connecting end of an Hvac_bend.

4.2.143.4 length

The length refers to the extent of the Hvac_bend from beginning to end.

4.2.144. Hvac_branch_connection

An Hvac_branch_connection is a connection between the logical termination of one Hvac_section_segment (see 4.2.169) and a point on another Hvac_section segment other than a termination.

The data associated with an Hvac_branch_connection are the following:

— branch_sequence_id.

This attribute specifies an alphanumeric identifier that indicates the order that branches extend from the main Hvac_section_segment (see 4.2.169).

NOTE All branch_sequence_ids are unique with respect to the branches of a given Hvac_section_segment (see 4.2.169).

4.2.145. Hvac_component

An Hvac_component is a type of Plant_item (see 4.2.260) that is an individually identifiable item or combination of items that is part of an Hvac_system (see 4.2.176). Each Hvac_component may be one of the following: an Hvac_equipment (see 4.2.156), an Hvac_fitting (see 4.2.157), an Hvac_ducting (see 4.2.151), and Hvac_instrument (see 4.2.160), and an Hvac_flow_control_device (see 4.2.158).

EXAMPLE The description attribute inherited from Plant_item (see 4.2.260) is used to describe the Hvac_component. Examples to descriptions include "air handling unit", "chiller", or "space heater".

An Hvac_component applies to any element that is a subset member of an Hvac_system (see 4.2.176).

The data associated with an Hvac_component are the following:

— design_flow_rate;

— design_flow_condition;

— design_pressure;

— design_temperature;

— pressure_loss_coefficient;

— pressure_drop;

— velocity.

4.2.145.1 design_flow_rate

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This attribute specifies the required flow volume over a specific unit of time.

4.2.145.2 design_flow_condition

This attribute defines the flow volume under standard operating procedures.

4.2.145.3 design_pressure

This attribute specifies the maximum allowable pressure at the Hvac_connector (see **4.2.147**). It may be specified as a single value or as a range of values.

NOTE 1 This value is normally created as part of doing 3D analysis of the Hvac_system (see **4.2.176**) design.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.145.4 design_temperature

This attribute specifies the maximum allowable temperature at the Hvac_connector (see **4.2.147**). It may be specified as a single value or as a range of values.

NOTE 1 This value is normally created as part of doing 3D analysis of the Hvac_system (see **4.2.176**) design.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.145.5 pressure_loss_coefficient

This attribute specifies a mathematical expression applied to the Hvac_system (see **4.2.176**) pressure to indicate loss to the system air flow due to internal system factors such as friction and turbulence.

4.2.145.6 pressure_drop

This attribute specifies the loss of air flow due to leaks, friction, or distance.

4.2.145.7 velocity

This attribute specifies the distance which air moves per unit of time, usually in feet per minute or feet per second.

4.2.146. Hvac_component_thickness

An Hvac_component_thickness is the skin thickness of the Hvac_component (see **4.2.145**).

The data associated with an Hvac_component_thickness are the following:

- sheet_metal_thickness;
- thickness_type.

4.2.146.1 sheet_metal_thickness

This attribute specifies the dimension between two of the sheet metals opposite surfaces. The thickness specifies the perpendicular distance between the two faces of the sheet metal. It may be specified as a single value or as a range of values.

NOTE See Annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.146.2 thickness_type

This attribute specifies the specific unit measurement type applied to quantify the thickness for a given element of an Hvac_system (see 4.2.176).

4.2.147. Hvac_connector

An Hvac_connector is a type of Plant_item_connector (see 4.2.265) that is intended to establish a material flow connection between two Plant_item (see 4.2.260) objects. within an Hvac_system (see 4.2.176).

The data associated with an Hvac_connector are the following:

- name;
- hvac_connector_specification;
- hvac_joint_inspection_specification;
- connector_flow_direction;
- hvac_joint_test_specification;
- hvac_joint_engagement_length;
- hvac_joint_joining_type;
- hvac_joint_sealant_type;
- hvac_joint_joint_type;
- hvac_joint_tightness.

4.2.147.1 name

This attribute specifies a textual label given to the Hvac_connector.

4.2.147.2 hvac_connector_specification

This attribute specifies the specification associated with the Hvac_connector. There may be more than one hvac_connector_specification for an Hvac_connector.

EXAMPLE Examples of the identified connector_specification include insulation specification, end preparation specification, and thread specification.

4.2.147.3 hvac_joint_inspection_specification

This attribute specifies the criteria for the review and approval processes of Hvac_component (see 4.2.145) connections.

4.2.147.4 connector_flow_direction

This attribute specifies the direction process air moves past the Plant_item (see 4.2.260). The value of connector_flow_direction is one of the following:

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- both
- inlet
- outlet

4.2.147.5 hvac_joint_test_specification

This attribute specifies the test and evaluation procedures which apply to Hvac_component (see **4.2.145**) connections.

4.2.147.6 hvac_joint_engagement_length

This attribute specifies the length of the interface between joined Hvac_components (see **4.2.145**).

4.2.147.7 hvac_joint_joining_type

This attribute specifies the method of mechanically joining the Hvac_components (see **4.2.145**). The value of the hvac_joint_joining_type may be one of the following:

- weld
- solder
- lapped_rivet
- sheet_metal_screw

4.2.147.8 hvac_joint_sealant_type

This attribute specifies the method used to seal the joint in order to satisfy the leak condition specified by the hvac_joint_tightness. The value of the hvac_joint_sealant_type may be one of the following:

- hvac_gasket
- hvac_thermal_fit_band
- hvac_duct_sealant
- hvac_tape

4.2.147.8.1 hvac_gasket

The hvac_gasket is a seal or packing used between components to prevent the escape of air.

4.2.147.8.2 hvac_thermal_fit_band

The hvac_thermal_fit_band is usually associated with spiral duct work where one piece is slid into another. The thermal_fit_band or coupler is placed around the joint and when heated seals the ducts together.

4.2.147.8.3 hvac_duct_sealant

The hvac_duct_sealant is an adhesive agent used to secure hvac components to prevent seepage of moisture or air.

4.2.147.8.4 hvac_tape

The hvac_tape provides a seal to the hvac_joint_joining_type

4.2.147.9 hvac_joint_joint_type

This attribute specifies the method used to join Plant_item_connection_occurrence (see **4.2.264**) objects.

4.2.147.10 hvac_joint_tightness

This attribute specifies the ability of the joint to resist leakage. The value of hvac_joint_tightness is one of the following:

- air_tight
- water_tight
- non_water_tight
- drip_tight

4.2.147.10.1 air_tight

An air_tight joint shall not allow any gas to leak through the joint.

4.2.147.10.2 water_tight

A water_tight joint shall not allow any water to leak through the joint.

4.2.147.10.3 non_water_tight

Non_water_tight refers to an hvac joint description which is not required to prevent or retard the passage of any liquid or air at the designated hvac joint.

4.2.147.10.4 drip_tight

A drip_tight joint shall not allow any fluid, including air to leak from the joint.

4.2.148. Hvac_connector_service_characteristic

An Hvac_connector_service_characteristic defines the operating conditions for which the Hvac_connector (see **4.2.147**) is designed.

The data associated with an Hvac_connector_service_characteristic are the following:

- design_pressure;
- design_temperature.

4.2.148.1 design_pressure

This attribute specifies the maximum allowable pressure at the Hvac_connector (see **4.2.147**). It may be specified as a single value or as a range of values.

NOTE 1 This value is normally created as part of doing 3D analysis of the Hvac_system (see **4.2.176**) design.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.148.2 design_temperature

This attribute specifies the maximum allowable temperature at the Hvac_connector (see **4.2.147**). It may be specified as a single value or as a range of values.

NOTE 1 This value is normally created as part of doing 3D analysis of the Hvac_system (see **4.2.176**) design.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.149. Hvac_coupling

An Hvac_coupling is a type of Hvac_fitting (see **4.2.157**) which makes a flexible or rigid connection between two Hvac_component (see **4.2.145**) objects.

The data associated with an Hvac_coupling are the following:

- end_1_connector;
- end_2_connector;
- length;
- offset_x;
- offset_y.

4.2.149.1 end_1_connector

This attribute is the primary connecting end of an Hvac_coupling.

4.2.149.2 end_2_connector

This attribute is the secondary connecting end of an Hvac_coupling.

4.2.149.3 length

This attribute is the distance of the Hvac_coupling from beginning to end.

4.2.149.4 offset_x

This attribute specifies the distance between end_connector_1 and end_connector_2 as measured along the x axis of the Hvac_cross_section (see **4.2.150**).

4.2.149.5 offset_y

This attribute specifies the distance between end_connector_1 and end_connector_2 as measured along the y axis of the Hvac_cross_section (see **4.2.150**).

4.2.150. Hvac_cross_section

An Hvac_cross_section is a planar shape created by a plane cutting through an Hvac_component (see **4.2.145**) at a right angle to the components centreline axis. This reveals the external outline of the component. Each Hvac_cross_section may be one of the following: a Cross_section_flat_oval (see **4.2.78**), a Cross_section_non_standard (see **4.2.79**), a Cross_section_radiused_corner (see **4.2.80**), a Cross_section_rectangular (see **4.2.81**), a Cross_section_round (see **4.2.82**), and a Cross_section_triangular (see **4.2.83**).

The data associated with an `Hvac_cross_section` are the following:

— `equivalent_length` .

The term `equivalent_length` with respect to the `Hvac_cross_section` means both width and height dimensions are the same.

4.2.151. `Hvac_ducting`

An `Hvac_ducting` is a type of `Ducting_component` (see **4.2.90**) and a type of `Hvac_component` (see **4.2.145**) that is an individually identifiable piece or section of ducting that is part of an `Hvac_system` (see **4.2.176**). The `hvac_specification_id` is a designation that differentiates one `Hvac_specification` (see **4.2.175**) from another.

The data associated with an `Hvac_ducting` are the following:

— `duct_path`;

— `duct_seam`;

— `length`;

— `end_1_connector`;

— `end_2_connector`.

4.2.151.1 `duct_path`

This attribute is the centreline trace of the `Hvac_ducting`.

4.2.151.2 `duct_seam`

This attribute refers to the line formed where two surfaces of the duct overlap each other.

4.2.151.3 `length`

This attribute is the distance of the `Hvac_ducting` from beginning to end.

4.2.151.4 `end_1_connector`

The `end_1_connector` is the primary connecting end of a piece of duct.

4.2.151.5 `end_2_connector`

The `end_2_connector` is the secondary connecting end of a piece of duct.

4.2.152. `Hvac_elbow_90deg_reducing`

The `Hvac_elbow_90deg_reducing` is a type of `Hvac_fitting` (see **4.2.157**) in which the flow of the air changes direction through a 90 degree turn and the cross section transitions from one size diameter to another.

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In terms of geometric construction, there are two closed curves with an interior trace curve from centre to centre upon which the surface is created.

NOTE 1 In terms of geometric construction, there are two closed curves with an interior trace curve from centre to centre upon which the surface is created.

NOTE 2 Figure 31 depicts an Hvac_elbow_90deg_reducing.

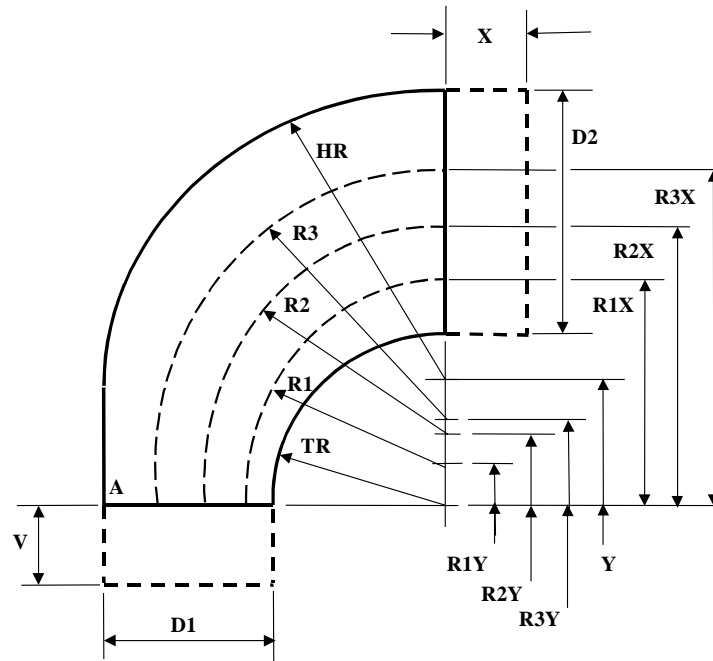


Figure 31 - Hvac_elbow_90deg_reducing

The data associated with an Hvac_elbow_90deg_reducing are the following:

- angle;
- throat_radius;
- heel_radius;
- heel_radius_centre_offset;
- end_1_connector;
- end_2_connector.

4.2.152.1 angle

This attribute specifies the sweep angle in degrees for the component elbow.

4.2.152.2 throat_radius

This attribute specifies the inside radius for the component elbow.

4.2.152.3 heel_radius

This attribute specifies the outside radius for the component elbow.

4.2.152.4 heel_radius_centre_offset

This attribute specifies the vertical distance from the throat centre to the splitter centre.

4.2.152.5 end_1_connector

The end_1_connector is the primary connecting end of a component elbow.

4.2.152.6 end_2_connector

The end_2_connector is the secondary connecting end of a component elbow.

4.2.153. Hvac_elbow_centred

The Hvac_elbow_centred is a type of Hvac_fitting (see **4.2.157**) in which the flow of the air changes direction.

In terms of geometric construction, there are two closed curves with an interior trace curve from centre to centre upon which the surface is created.

NOTE Figure 32 depicts an Hvac_elbow_centred.

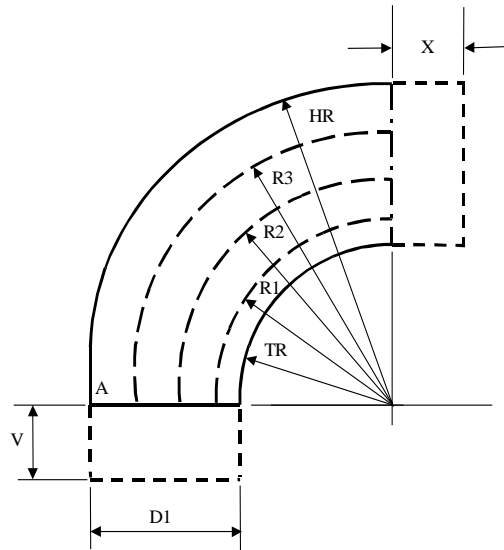


Figure 32 - Hvac_elbow_centred

The data associated with an Hvac_elbow_centred are the following:

— angle;

— width;

— height;

— throat_radius;

— heel_radius;

— end_1_connector;

— end_2_connector.

4.2.153.1 angle

This attribute specifies the sweep angle in degrees for the component elbow.

4.2.153.2 width

This attribute specifies the distance between the sides of the elbow component. Not indicated on the sketch.

4.2.153.3 height

This attribute specifies the vertical distance from the throat centre to the heel_radius.

4.2.153.4 throat_radius

This attribute specifies the inside radius for the component elbow.

4.2.153.5 heel_radius

This attribute specifies the outside radius for the component elbow.

4.2.153.6 end_1_connector

The end_1_connector is the primary connecting end of a component elbow.

4.2.153.7 end_2_connector

The end_2_connector is the secondary connecting end of a component elbow.

4.2.154. Hvac_elbow_mitre

An Hvac_elbow_mitre is a type of Hvac_fitting (see **4.2.157**) developed through the use of two or more straight sections of vent that are beveled and joined on a line bisecting the angle of junction.

NOTE Figure 33 depicts an Hvac_elbow_mitre.

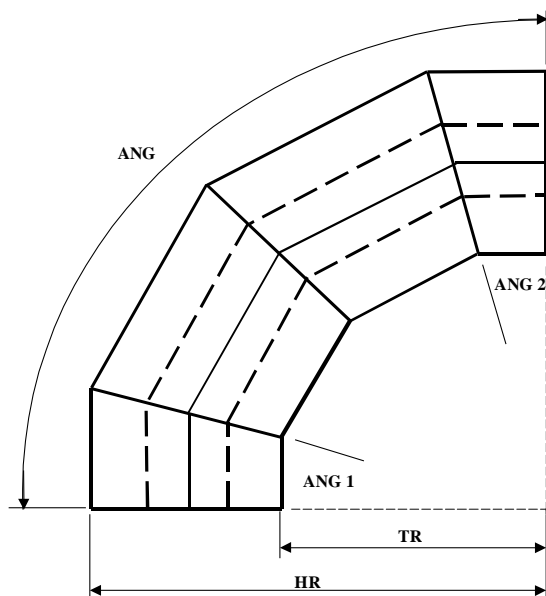


Figure 33 - Hvac_elbow_mitre

The data associated with an Hvac_elbow_mitre are the following:

- angle_first_section;
- angle_last_section;
- number_of_sections;
- sweep_angle;
- throat_radius;
- heel_radius;
- end_1_connector;
- end_2_connector.

4.2.154.1 angle_first_section

This attribute specifies the sweep angle in degrees for the first section of the mitred elbow development.

4.2.154.2 angle_last_section

This attribute specifies the sweep angle in degrees for the last section of the mitred elbow development.

4.2.154.3 number_of_sections

This attribute specifies how many sections are necessary to develop the mitred elbow.

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4.2.154.4 sweep_angle

This attribute specifies the overall angle of the elbow.

4.2.154.5 throat_radius

This attribute specifies the inside radius for the component elbow.

4.2.154.6 heel_radius

This attribute specifies the outside radius for the component elbow.

4.2.154.7 end_1_connector

The end_1_connector is the primary connecting end of a component elbow.

4.2.154.8 end_2_connector

The end_2_connector is the secondary connecting end of a component elbow.

4.2.155. Hvac_end_fitting

An Hvac_end_fitting is a type of Hvac_fitting (see **4.2.157**) which only connects to one other Hvac_component (see **4.2.145**).

The data associated with an Hvac_end_fitting are the following:

- end_1_connector;
- opening_type.

4.2.155.1 end_1_connector

The end_1_connector is the primary connecting end of an Hvac_end_fitting.

4.2.155.2 opening_type

This attribute specifies the type of opening at the end of the fitting which does not have a connector.

4.2.156. Hvac_equipment

An Hvac_equipment is a type of Hvac_component (see **4.2.145**) used to develop a functional Hvac_system (see **4.2.176**).

4.2.157. Hvac_fitting

An Hvac_fitting is an individual component of an hvac duct system. Each Hvac_fitting may be one of the following: Hvac_coupling (see **4.2.149**), an Hvac_elbow_90deg_reducing (see **4.2.152**), an Hvac_elbow_centred (see **4.2.153**), an Hvac_elbow_mitre (see **4.2.154**), an Hvac_end_fitting (see **4.2.155**), an Hvac_fitting (see **4.2.157**), an Hvac_gasket (see **4.2.159**), an Hvac_offset_centred (see **4.2.161**), an Hvac_offset_ogee_centred (see **4.2.162**), an Hvac_takeoff (see **4.2.178**), an Hvac_transition (see **4.2.179**), and an Hvac_transition_slanted (see **4.2.180**).

4.2.158. Hvac_flow_control_device

An `Hvac_flow_control_device` is a type of `Hvac_component` (see **4.2.145**) of the `Hvac_system` (see **4.2.176**) that regulates the airflow based on the inline design conditions and settings.

Note Such devices fall into four categories and include sensors, controllers, controlled devices, and auxiliary devices. Auxiliary devices include relays, transducers, and switches.

The data associated with an `Hvac_flow_control_device` are the following:

- `flow_control_device_id`;
- `control_device_type`;
- `end_1_connector`;
- `end_2_connector`;
- `control_point_units`;
- `control_point_nominal_value`;
- `control_point_min_value`;
- `control_point_max_value`;
- `control_point_set_point_value`.

4.2.158.1 flow_control_device_id

The `flow_control_device_id` is the unique identifier for each of the inline control devices. These include sensors, controllers, controlled devices, and auxiliary devices. It is the unique id for the `Hvac_flow_control_devices`.

4.2.158.2 control_device_type

This attribute specifies the type of device which controls flow.

4.2.158.3 end_1_connector

The `end_1_connector` is the primary connecting end of an `Hvac_flow_control_device`.

4.2.158.4 end_2_connector

The `end_2_connector` is the secondary connecting end of an `Hvac_flow_control_device`.

4.2.158.5 control_point_units

this attribute specifies the units as pounds per square inch.

4.2.158.6 control_point_nominal_value

This attribute specifies the average controlled airflow in pounds per square inch (psi).

4.2.158.7 control_point_min_value

This attribute specifies the minimum controlled airflow in pounds per square inch (psi).

4.2.158.8 control_point_max_value

This attribute specifies the maximum controlled airflow in pounds per square inch (psi).

4.2.158.9 control_point_set_point_value

This attribute specifies the variable value assigned as the primary parameter upon which the Hvac_system (see **4.2.176**) maintains temperature control.

4.2.159. Hvac_gasket

An Hvac_gasket is a type of Hvac_component (see **4.2.145**) used between components to prevent the escape of air.

Example An example of an Hvac_gasket is is a seal or packing.

4.2.160. Hvac_instrument

An Hvac_instrument is a type of Hvac_fitting (see **4.2.157**) which monitors, measures, indicates, and records the system status.

Note The purpose of the Hvac_instrument is to provide information to the plant operator for analyzing, troubleshooting, and improving the operation of the Hvac_system (see **4.2.176**).

The data associated with an Hvac_instrument are the following:

- instrument_id;
- units;
- low_range;
- high_range;
- type;
- parameter_measured;
- low_alarm;
- high_alarm;
- nameplate_inscription;
- divisions.

4.2.160.1 instrument_id

This attribute specifies the unique identifier for each Hvac_instrument.

4.2.160.2 units

This attribute specifies the units recorded by the Hvac_instrument.

Note The units applied to Hvac_instruments will vary in accordance with the particular Hvac_system (see **4.2.176**) function that is monitored.

4.2.160.3 low_range

This attribute specifies the low end setting for a particular Hvac_system (see **4.2.176**) function.

Example Oil pressure gauge.

4.2.160.4 high_range

This attribute specifies high end setting for an Hvac_system (see **4.2.176**) function.

4.2.160.5 type

This attribute specifies a specific kind of Hvac_instrument device used to monitor an Hvac_system (see **4.2.176**).

4.2.160.6 parameter_measure

This attribute specifies a function that is monitored or measured.

Example Voltage, current, pressure, velocity.

4.2.160.7 low_alarm

This attribute specifies a function of an Hvac_instrument device.

4.2.160.8 high_alarm

This attribute specifies a function of an Hvac_instrument device.

4.2.160.9 nameplate_inscription

This attribute specifies the text on the nameplate used to identify an Hvac_instrument (see **4.2.160**) and the function it is designed to carry out.

4.2.160.10 divisions

This attribute specifies the gradations on the gauge.

4.2.161. Hvac_offset_centred

An Hvac_offset_centred is a type of Hvac_connector (see **4.2.147**) fitting.

The data associated with an Hvac_offset_centred are the following:

- angle;
- offset;
- length;
- throat_radius;
- heel_radius;
- end_1_connector;
- end_2_connector.

4.2.161.1 angle

This attribute specifies the number of degrees for the radial sections at both top and bottom.

4.2.161.2 offset

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This attribute specifies the perpendicular distance between the centres of two Hvac_components (see 4.2.145) which are to be connected.

4.2.161.3 length

This attribute specifies the horizontal distance between two Hvac_component (see 4.2.145) objects from connection point one to connection point two.

4.2.161.4 throat_radius

This attribute specifies the inside radius for the end sections of the Hvac_offset_centred fitting.

4.2.161.5 heel_radius

This attribute specifies the outside radius for the end sections of the Hvac_offset_centred fitting.

4.2.161.6 end_1_connector

The end_1_connector is the primary connecting end of an Hvac_offset_centred fitting.

4.2.161.7 end_2_connector

The end_2_connector is the secondary connecting end of an Hvac_offset_centred fitting.

4.2.162. Hvac_offset_ogee_centred

An Hvac_offset_ogee_centred is a type of Hvac_fitting (see 4.2.157) that appears to be an “s” shaped component.

NOTE Figure 34 depicts an Hvac_offset_ogee_centred.

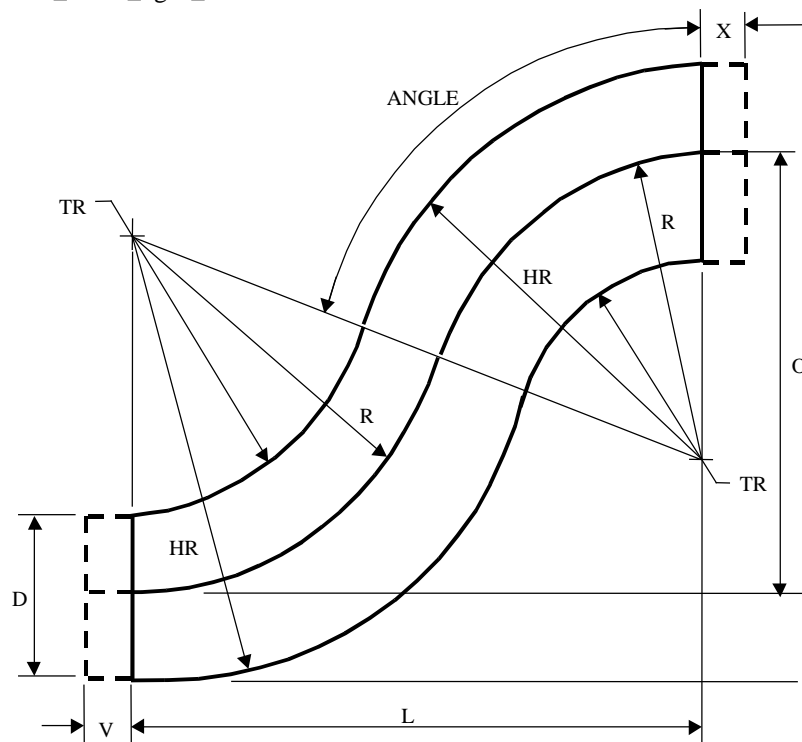


Figure 34 - Hvac_offset_ogee_centred

The data associated with an Hvac_offset_ogee_centred are the following:

- angle;
- offset;
- length;
- throat_radius;
- heel_radius;
- end_1_connector;
- end_2_connector.

4.2.162.1 angle

This attribute specifies the number of degrees applied to the upper and lower heel and throat radius construction.

4.2.162.2 offset

This attribute specifies the perpendicular distance between the centrelines of the upper and lower connecting ends of the `Hvac_offset_ogee_centred` component.

4.2.162.3 length

This attribute specifies the horizontal distance between `end_1_connector` and `end_2_connector` of the `Hvac_offset_ogee_centred` fitting.

4.2.162.4 throat_radius

This attribute specifies the interior radius of the radial transition of the `Hvac_offset_ogee_centred`. It applies to the upper and lower transitions.

4.2.162.5 heel_radius

This attribute specifies the exterior radius of the radial transition of the `Hvac_offset_ogee_centred`. It applies to the upper and lower transition.

4.2.162.6 end_1_connector

The `end_1_connector` is the primary connecting end of an `Hvac_offset_ogee_centred`.

4.2.162.7 end_2_connector

The `end_2_connector` is the secondary connecting end of an `Hvac_offset_ogee_centred`.

4.2.163. Hvac_plant_item_branch_connection

An `Hvac_plant_item_branch_connection` is a connection between an `Hvac_plant_item_branch_connection` and a point on an `Hvac_section_segment` (see **4.2.169**) other than an `Hvac_section_segment_terminator` (see **4.2.171**). Each `Hvac_plant_item_branch_connection` defines the branches of exactly one `Hvac_section_segment` (see **4.2.169**).

The data associated with an `Hvac_plant_item_branch_connection` are the following:

- `branch_sequence_id`.

The `branch_sequence_id` specifies an alphanumeric identifier that indicates the order that branches extend from the main `Hvac_section_segment` (see **4.2.169**).

NOTE All `branch_sequence_ids` are unique with respect to the branches of a given `Hvac_section_segment` (see **4.2.169**).

4.2.164. Hvac_plant_item_branch_connector

An `Hvac_plant_item_branch_connector` is a type of `Functional_connector` (see **4.2.128**) which connects an `Hvac_plant_item_branch_connector` to a point on an `Hvac_section_segment` (see **4.2.169**) other than a termination. The `Hvac_plant_item_branch_connector` branches from the `Hvac_section_segment`.

4.2.165. Hvac_plant_item_connection

An `Hvac_plant_item_connection` is a linkage between two or more `Hvac_plant_item_connector` (see **4.2.166**) objects. The joining conditions may be specified for the connection.

4.2.166. Hvac_plant_item_connector

An `Hvac_plant_item_connector` is a type of `Functional_connector` (see **4.2.128**) which is a feature of a `Plant_item` (see **4.2.260**) that is designed to connect to a connector on another `hvac Plant_item`.

4.2.167. Hvac_plant_item_termination

An `Hvac_plant_item_termination` is a type of `Hvac_section_segment_termination` (see **4.2.171**) that connects to an `Hvac_plant_item_connection` (see **4.2.165**).

4.2.168. Hvac_section_branch_termination

An `Hvac_section_branch_termination` is a type of `Hvac_section_segment_termination` (see **4.2.171**) that connects to an `Hvac_section_segment` (see **4.2.169**) at a point other than a termination.

4.2.169. Hvac_section_segment

An `Hvac_section_segment` is an element of an `Hvac_system_section` (see **4.2.177**) which terminates at a functional `Plant_item_connector` (see **4.2.265**), a tap into an `Hvac_system_section`, or a point where the stream diverges or converges.

The data associated with an `Hvac_section_segment` are the following:

- `hvac_segment_id`;
- `pressure_drop`.

4.2.169.1 hvac_segment_id

This attribute specifies a unique identifier for the `Hvac_section_segment`.

4.2.169.2 pressure_drop

This attribute specifies the drop in pressure in the `Hvac_section_segment`.

4.2.170. Hvac_section_segment_insulation

An Hvac_section_segment_insulation is a piece of insulation which is applied uniformly to the Hvac_section_segment (see **4.2.169**).

The data associated with an Hvac_section_segment_insulation are the following:

- insulation_thickness;
- insulation_type;
- insulation_description;
- insulation_specification.

4.2.170.1 insulation_thickness

This attribute specifies the total thickness of the insulation measure from the surface of the Hvac_section_segment (see **4.2.169**) outward.

4.2.170.2 insulation_type

This attribute specifies the type of material which keeps the hot side hot and the cold side cold.

4.2.170.3 insulation_description

This attribute specifies a description of the insulation.

4.2.170.4 insulation_specification

This attribute specifies a document which describes the properties of the insulation.

4.2.171. Hvac_section_segment_termination

An Hvac_section_segment_termination is one of the logical end-points of an Hvac_section_segment (see **4.2.169**). Each Hvac_section_segment_termination may be one of the following: an Hvac_section_branch_termination (see **4.2.168**), an Hvac_section_termination (see **4.2.172**), an Hvac_section_to_section_termination (see **4.2.174**), and an Hvac_plant_item_termination (see **4.2.167**).

The data associated with an Hvac_section_segment_termination are the following:

- flow_direction.

The flow_direction is the direction of flow of the fluid with respect to the Hvac_section_segment (see **4.2.169**).

4.2.172. Hvac_section_termination

An Hvac_section_termination is a type of Hvac_section_segment_termination (see **4.2.171**) that begins or ends an Hvac_section_segment (see **4.2.169**).

The data associated with an Hvac_section_termination are the following:

- location;
- start_or_end.

4.2.172.1 location

This attribute specifies the relative distance in the X, Y, Z directions of the position of the end of the Hvac_section_segment (see **4.2.169**), from the plant origin.

NOTE The location position may also be defined by where it connects to an upstream piece of Equipment (see **4.2.104**) or Hvac_section_segment.

4.2.172.2 start_or_end

This attribute specifies an enumerated value that defines the side of the Hvac_ducting (see **4.2.151**) on which the section termination lies.

NOTE A value of 'start' indicates the section termination is on the upstream end, and a value of 'end' indicates that the section termination is on the downstream end.

4.2.173. Hvac_section_to_section_connection

An Hvac_section_to_section_connection is a connection between two Hvac_section_segments (see **4.2.169**) .

The data associated with an Hvac_section_to_section_connection are the following:

— section_to_section_connection_id.

The section_to_section_connection_id is a unique identifier of the connection between two Hvac_section_segments (see **4.2.169**).

4.2.174. Hvac_section_to_section_termination

An Hvac_section_to_section_termination is the terminating segment of an Hvac_section_segment (see **4.2.169**) which is the terminating segment of an Hvac_section_segment (see **4.2.169**).

4.2.175. Hvac_specification

The data associated with an Hvac_specification are the following:

— hvac_specification_id;

— name;

— owner;

— service_description.

4.2.175.1 hvac_specification_id

This attribute specifies a designation that differentiates one Hvac_specification from another.

4.2.175.2 name

This attribute specifies a textual label given to the Hvac_specification.

4.2.175.3 owner

This attribute specifies the owner as a point of contact for the specification.

4.2.175.4 service_description

This attribute specifies the service that this specification applies to.

4.2.176. Hvac_system

An Hvac_system is a type of Ducting_system (see **4.2.91**) that controls the temperature, humidity, cleanliness, and circulation of environmental air as required in a Building (see **4.2.14**).

4.2.177. Hvac_system_section

An Hvac_system_section consists of one or many Hvac_section_segments (see **4.2.169**).

The data associated with an Hvac_system_section are the following:

— hvac_section_id;

The hvac_section_id specifies a unique identifier for the Hvac_section_segment (see **4.2.169**).

4.2.178. Hvac_takeoff

An Hvac_takeoff is a type of Hvac_fitting (see **4.2.157**) which has three end connectors.

The data associated with an Hvac_takeoff are the following:

— end_1_connector;

— end_2_connector;

— end_3_connector;

— centre_to_end_1_length;

— centre_to_end_2_length;

— centre_to_end_3_length;

— takeoff_angle.

4.2.178.1 end_1_connector

The end_1_connector is the connector to the inlet of the Hvac_takeoff.

4.2.178.2 end_2_connector

The end_2_connector is the connector to the outlet of the Hvac_takeoff.

4.2.178.3 end_3_connector

The end_3_connector is the connector to the branch of the Hvac_takeoff.

4.2.178.4 centre_to_end_1_length

This attribute specifies the distance from the intersection of the branch and the run to end_1_connector which is the inlet of the Hvac-fitting (see **4.2.157**).

4.2.178.5 centre_to_end_2_length

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This attribute specifies the distance from the intersection of the branch and the run to end_2_connector which is the outlet of the Hvac_fitting (see 4.2.157).

4.2.178.6 centre_to_end_3_length

This attribute specifies the distance from the intersection of the branch and the run to end_3_connector which is the branch of the Hvac_fitting (see 4.2.157).

4.2.178.7 takeoff_angle

This attribute specifies the angle between the through run of the Hvac_fitting (see 4.2.157) and the line segment connecting the intersection of the branch and the run to the termination to the end_3_connector.

4.2.179. Hvac_transition

An Hvac_transition is a type of Hvac_fitting (see 4.2.157) between two Hvac_section_segments (see 4.2.169) having different cross sections, shapes, size, or having an offset.

NOTE Figure 35 depicts an Hvac_transition from Rectangular to Round

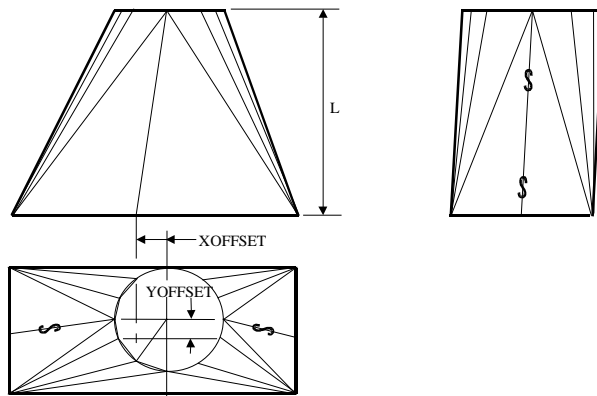


Figure 35 - Transition - Rectangular to Round

The data associated with an Hvac_transition are the following:

- offset_x;
- offset_y;
- length;
- end_1_connector;
- end_2_connector.

4.2.179.1 offset_x

This attribute specifies the distance from the inlet to the outlet as shown by XOFFSET in Figure 35

4.2.179.2 offset_y

This attribute specifies the distance from the inlet to the outlet as shown by YOFFSET in Figure 35

4.2.179.3 length

This attribute specifies the length of the transition as shown by L in Figure 35.

4.2.179.4 end_1_connector

The end_1_connector is the primary connecting end of a transition.

4.2.179.5 end_2_connector

The end_2_connector is the secondary connecting end of a transition.

4.2.180. Hvac_transition_slanted

An Hvac_transition_slanted is a type of Hvac_fitting (see **4.2.157**) which provides a change in size and a change in direction between two Plant_items (see **4.2.260**).

NOTE Figure 36 depicts an Hvac_transition_slanted from Rectangle to Round

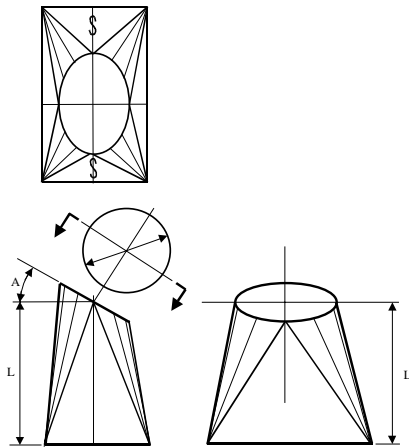


Figure 36 - Transition - Rectangle to Round Slanted

The data associated with an Hvac_transition_slanted are the following:

- slant_angle;
- length;
- end_1_connector;
- end_2_connector.

4.2.180.1 slant_angle

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This attribute specifies the slant angle of the transition as shown by A in Figure 36.

4.2.180.2 length

This attribute specifies the length between end_1_connector and end_2_connector.

4.2.180.3 end_1_connector

The end_1_connector is the primary connecting end of a slanted transition.

4.2.180.4 end_2_connector

The end_2_connector is the secondary connecting end of a slanted transition.

4.2.181. Hybrid_shape_representation

A Hybrid_shape_representation is a type of Shape_representation. (see **4.2.309**).

4.2.182. Inline_equipment

An Inline_equipment is a type of Equipment (see **4.2.104**) and Piping_system_component (see **4.2.250**) that is inserted into the flow of a process stream to perform a function.

4.2.183. Inline_instrument

An Inline_instrument is a type of Instrument (see **4.2.188**) and Piping_system_component (see **4.2.250**) that is inserted into the flow of a process stream to measure some characteristic of the stream.

EXAMPLE Thermowells, pressure gauges, and flowmeters are examples of Inline_instruments.

The data associated with an Inline_instrument are the following:

— control_loop_id.

A control_loop_id specifies a unique identifier for a control module that is implemented by an Inline_instrument.

4.2.184. Insert

An Insert is a type of Fitting (see **4.2.118**) with one external and one smaller internal end.

NOTE Figure 37 depicts a typical Insert.

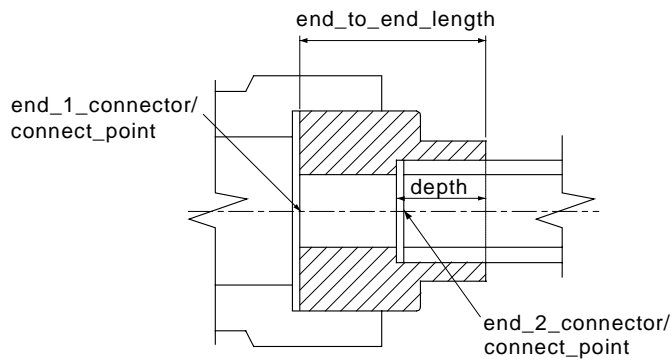


Figure 37 - Insert

The data associated with an Insert are the following:

- end_1_connector;
- end_2_connector;
- end_to_end_length.

4.2.184.1 end_1_connector

The end_1_connector specifies the Piping_connector (see **4.2.242**) designated as Male_end (see **4.2.215**).

4.2.184.2 end_2_connector

The end_2_connector specifies the Piping_connector (see **4.2.242**) designated as Female_end (see **4.2.116**).

4.2.184.3 end_to_end_length

The end_to_end_length specifies the external length of the Insert from the end-one face to the end-two face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.185. Inside_and_thickness

An Inside_and_thickness is a type of Piping_size_description (see **4.2.244**) that describes the size of a Piping_system_component (see **4.2.250**) or a Piping_connector (see **4.2.242**) using an actual (intended) inside diameter and wall thickness.

The data associated with an Inside_and_thickness are the following:

- inside_diameter;
- thickness.

4.2.185.1 inside_diameter

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The `inside_diameter` specifies the actual (intended, not nominal) inside diameter of the `Piping_system_component` (see **4.2.250**) or `Piping_connector` (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.185.2 thickness

The `thickness` specifies the minimum distance between the inside and outside piping wall surfaces required for the `Piping_system_component` (see **4.2.250**) or `Piping_connector` (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.186. Inspection_condition

The `Inspection_condition` is a characteristic which shall be required to be attained for the inspection to be accomplished.

The data associated with an `Inspection_condition` are the following:

— `condition_name`;

— `value`.

4.2.186.1 condition_name

The `condition_name` specifies the characteristic that is being defined.

EXAMPLE “welding preheating temp” and “post heating temp” are inspection condition names.

4.2.186.2 value

The `value` specifies the specific quantity or alphanumeric qualifier for the characteristic that affects the inspection.

4.2.187. Installed_physical_design_view

An `Installed_physical_design_view` is an indication that the `Plant_item` (see **4.2.260**) described by a `Physical_design_view` (see **4.2.235**) is physically installed within the `Plant` (see **4.2.258**).

NOTE Within a usage of this part of ISO 10303, all `Plant_items` (see **4.2.260**) are considered as planned physical design views unless they are related to `Installed_physical_design_view`. This relationship indicates that the `Plant_item` is an actual item that currently exists or is installed in the `Plant` (see **4.2.258**).

The data associated with an `Installed_physical_design_view` are the following:

— `serial_number`.

The `serial_number` specifies a designation that uniquely identifies a particular physical `Plant_item` (see **4.2.260**) that is installed in a `Plant` (see **4.2.258**).

NOTE The designation is typically assigned and affixed by the manufacturer of the Plant_item (see 4.2.260).

4.2.188. Instrument

An Instrument is a type of Instrumentation_and_control_component (see 4.2.189) that monitors one or more performance characteristics of a system. Each Instrument may be one of the following: an Inline_instrument (see 4.2.183) or an Offline_instrument (see 4.2.224).

The data associated with an Instrument are the following:

- instrument_type;
- sensor_type;
- signal_type;
- stream_interaction_type.

4.2.188.1 instrument_type

The instrument_type specifies a classification of an Instrument based on its performance characteristics.

EXAMPLE Examples of instrument_type classifications include flow control, level control, pressure, or temperature.

4.2.188.2 sensor_type

The sensor_type specifies a classification of an Instrument actuator based on its operational characteristics.

4.2.188.3 signal_type

The signal_type specifies a classification of an Instrument signal based on its physical characteristics.

EXAMPLE Examples of instrument signal_type classifications include electric and pneumatic.

4.2.188.4 stream_interaction_type

The stream_interaction_type specifies a classification of an Instrument based on how the sensor is positioned to sense the stream.

EXAMPLE Examples of stream_interaction_types include outside, inserted, and immersed.

4.2.189. Instrumentation_and_control_component

An Instrumentation_and_control_component is a type of Plant_item (see 4.2.260) that is an individually identifiable item or combination of items that is part of the Instrumentation_and_control_system (see 4.2.190). Each Instrumentation_and_control_component may be an Instrument (see 4.2.188).

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EXAMPLE Examples of Instrumentation_and_control_component objects include wiring, switches, control valves, and gauges.

4.2.190. Instrumentation_and_control_system

An Instrumentation_and_control_system is a type of Plant_system (see **4.2.276**) that is a system of wiring, switches, controls, and other equipment associated with monitoring and controlling the performance characteristics of Plant_system objects.

The data associated with an Instrumentation_and_control_system are the following:

— type.

The type specifies a designation that classifies the Instrumentation_and_control_system based on the kind of service that it provides.

4.2.191. Insulation

An Insulation is a type of Plant_item (see **4.2.260**) that is a material or assembly of materials used to provide resistance to heat flow.

4.2.192. Interfering_shape_element

An Interfering_shape_element is the portion of the Plant_item_shape (see **4.2.273**) that is interfered with by a shape element of another Plant_item (see **4.2.260**).

NOTE This application object is intended to support design integration, specifically the need to identify the elements of the designs that physically interfere with one another.

The data associated with an Interfering_shape_element are the following:

— first_item;

— interference_colour;

— second_item.

4.2.192.1 first_item

The first_item specifies the plant_item_id of one of the Plant_items (see **4.2.260**) that is interfering.

4.2.192.2 interference_colour

The interference_colour specifies the colour that displays the element.

4.2.192.3 second_item

The second_item specifies the plant_item_id of one of the Plant_items (see **4.2.260**) that is interfering.

4.2.193. Lap_joint_flange

A Lap_joint_flange is a type of Flange (see 4.2.119) that has a rounded contour at the intersection of the bore and the Flange face in order to mate to a Lap_joint_stub_end (see 4.2.194).

NOTE 1 This Flange (see 4.2.119) can be swiveled around a Lap_joint_stub_end (see 4.2.194) in order to align bolt holes.

NOTE 2 Figure 38 depicts a typical Lap_joint_flange.

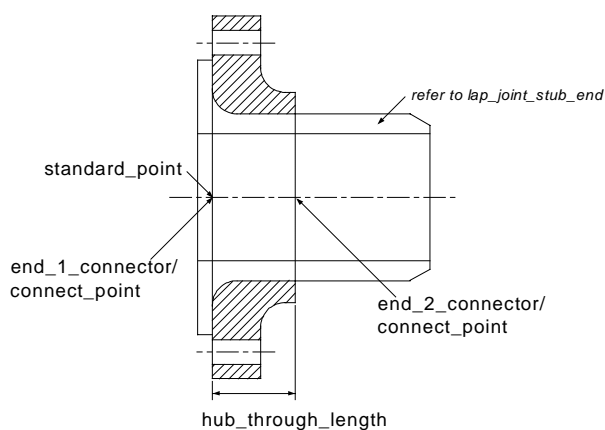


Figure 38 - Lap_joint_flange

4.2.194. Lap_joint_stub_end

A Lap_joint_stub_end is a type of Fitting (see 4.2.118) used with a Lap_joint_flange (see 4.2.193), consisting of a cylinder or barrel with an integral flat ring or lap around one end with a rounded contour at the external intersection of the barrel and the lap.

NOTE 1 Figure 39 depicts a typical Lap_joint_stub_end.

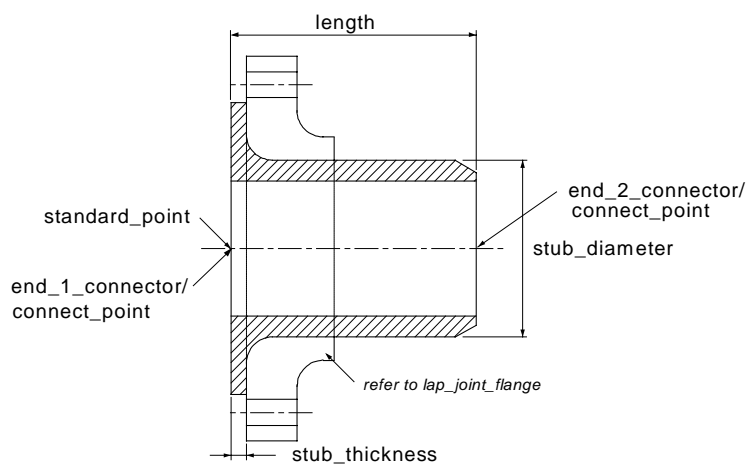


Figure 39 - Lap_joint_stub_end

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NOTE 2 End two is beveled for butt welding to pipe. The lap face normally has a flat or concentric serrated finish. This surface serves as the raised-face gasket surface of the Flange (see **4.2.119**) in Lap_joint_flange (see **4.2.193**) connections.

The data associated with a Lap_joint_stub_end are the following:

- end_1_connector;
- end_2_connector;
- length;
- stub_diameter;
- stub_thickness.

4.2.194.1 end_1_connector

The end_1_connector specifies the Piping_connector (see **4.2.242**) at the stub end face that connects to another Flange (see **4.2.119**) or Nozzle (see **4.2.222**).

4.2.194.2 end_2_connector

The end_2_connector specifies the Piping_connector (see **4.2.242**) at the stub end face that connects to a non-flange Piping_component (see **4.2.240**).

4.2.194.3 length

The length specifies the external distance between the lap face and the other stub end face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.194.4 stub_diameter

The stub_diameter specifies the nominal diameter of the Lap_joint_stub_end. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.194.5 stub_thickness

The stub_thickness specifies the distance between the inner and outer surfaces of the flared portion of the stub end. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.195. Lateral

A Lateral is a type of Fitting (see **4.2.118**) that is a three-way fitting having two ends opposite each other in a straight run and a branch outlet projecting from the run at an angle.

NOTE Figure 40 depicts a typical butt-weld Lateral.

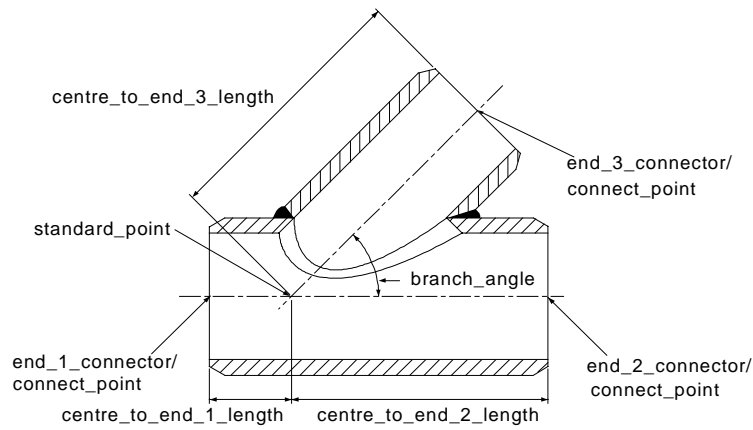


Figure 40 - Lateral

The data associated with a Lateral are the following:

- `branch_angle`;
- `centre_to_end_1_length`;
- `centre_to_end_2_length`;
- `centre_to_end_3_length`;
- `end_1_connector`;
- `end_2_connector`;
- `end_3_connector`.

4.2.195.1 `branch_angle`

The `branch_angle` specifies the angle that the branch projects from the straight run. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.195.2 `centre_to_end_1_length`

The `centre_to_end_1_length` specifies the distance between the point where the branch and straight run centrelines intersect and the straight-run face that is closest to the intersection. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.195.3 `centre_to_end_2_length`

The `centre_to_end_2_length` specifies the distance between the point where the branch and straight run centrelines intersect and the straight-run face that is furthest from the intersection. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.195.4 centre_to_end_3_length

The `centre_to_end_3_length` specifies the distance between the point where the branch and straight run centrelines intersect and the branch face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.195.5 end_1_connector

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) on the straight run that is closest to the intersection between the centrelines of the branch run and straight run.

4.2.195.6 end_2_connector

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) on the straight run that is furthest from the intersection between the centrelines of the branch run and straight run.

4.2.195.7 end_3_connector

The `end_3_connector` specifies the `Piping_connector` (see **4.2.242**) that connects to the branch line.

4.2.196. Line

A `Line` is a type of `Curve` (see **4.2.85**) that is a one-dimensional, contiguous set of points that are positioned at a constant distance from a vector or that constitute the shortest distance between two points.

4.2.197. Line_branch_connection

A `Line_branch_connection` is a connection between the logical termination of one `Piping_system_line_segment` (see **4.2.252**) and a point on another `Piping_system_line_segment` other than a termination. The former `Piping_system_line_segment` branches from the latter `Piping_system_line_segment`.

The data associated with a `Line_branch_connection` are the following:

— `line_number`.

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` (see **4.2.251**) and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

4.2.198. Line_branch_termination

A `Line_branch_termination` is a type of `Piping_system_line_segment_termination` (see **4.2.253**) that connects to a `Piping_system_line_segment` (see **4.2.252**) at a point other than a termination.

The data associated with a `Line_branch_termination` are the following:

— line_number.

The line_number specifies an alphanumeric identifier assigned to the Piping_system_line (see **4.2.251**) and can be used to uniquely define the Piping_system_line. Line_number is required for each Piping_system_line.

4.2.199. Line_less_piping_system

A Line_less_piping_system is a type of Piping_system (see **4.2.249**) that does not have a line designation as defined in Piping_system_line (see **4.2.251**).

4.2.200. Line_piping_system_component_assignment

A Line_piping_system_component_assignment is the relationship between a Piping_system_line (see **4.2.251**) and a Piping_system_component (see **4.2.250**) that is part of, or satisfies the need specified by, the Piping_system_line.

The data associated with a Line_piping_system_component_assignment are the following:

— line_number.

The line_number specifies an alphanumeric identifier assigned to the Piping_system_line (see **4.2.251**) and can be used to uniquely define the Piping_system_line. Line_number is required for each Piping_system_line.

4.2.201. Line_plant_item_branch_connection

A Line_plant_item_branch_connection is a connection between a Line_plant_item_branch_connector (see **4.2.202**) and a point on a Piping_system_line_segment (see **4.2.252**) other than a termination. The Line_plant_item_branch_connector branches from the Piping_system_line_segment.

The data associated with a Line_plant_item_branch_connection are the following:

— branch_sequence_id;

— line_number.

4.2.201.1 branch_sequence_id

The branch_sequence_id specifies an alphanumeric identifier that indicates the order that branches extend from the main Piping_system_line_segment (see **4.2.252**).

4.2.201.2 line_number

The line_number specifies an alphanumeric identifier assigned to the Piping_system_line (see **4.2.251**) and can be used to uniquely define the Piping_system_line. Line_number is required for each Piping_system_line.

4.2.202. Line_plant_item_branch_connector

A `Line_plant_item_branch_connector` is a type of `Functional_connector` (see 4.2.128) that participates in a `Line_plant_item_branch_connection` (see 4.2.201).

4.2.203. `Line_plant_item_connection`

A `Line_plant_item_connection` is a connection between the logical termination of a `Piping_system_line_segment` (see 4.2.252) and a `Line_plant_item_connector` (see 4.2.204).

The data associated with a `Line_plant_item_connection` are the following:

— `line_number`.

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` (see 4.2.251) and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

4.2.204. `Line_plant_item_connector`

A `Line_plant_item_connector` is a type of `Functional_connector` (see 4.2.128) that participates in a `Line_plant_item_connection` (see 4.2.203).

4.2.205. `Line_plant_item_termination`

A `Line_plant_item_termination` is a type of `Piping_system_line_segment_termination` (see 4.2.253) that connects to other `Line_to_line_termination` (see 4.2.207) objects.

The data associated with a `Line_plant_item_termination` are the following:

— `line_number`.

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` (see 4.2.251) and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

4.2.206. `Line_to_line_connection`

A `Line_to_line_connection` is a connection between the logical terminations of two or more `Piping_system_line_segment` (see 4.2.252) objects.

4.2.207. `Line_to_line_termination`

A `Line_to_line_termination` is a type of `Piping_system_line_segment_termination` (see 4.2.253) that connects to other `Line_to_line_termination` objects.

The data associated with a `Line_to_line_termination` are the following:

— `line_number`.

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` (see 4.2.251) and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

4.2.208. Lined_piping

A `Lined_piping` is a type of `Piping_spool` (see 4.2.246) with coating material on the inner side.

The data associated with a `Lined_piping` are the following:

- `lining_thickness_inside_pipe`;
- `lining_thickness_at_flange_face`.

4.2.208.1 lining_thickness_inside_pipe

The `lining_thickness_inside_pipe` specifies the thickness of the coating material on the inner surface of the `Piping_spool` (see 4.2.246).

4.2.208.2 lining_thickness_at_flange_face

The `lining_thickness_at_flange_face` specifies the thickness of the coating material on the connecting face of the `Flange` (see 4.2.119) at the ends of the `Piping_spool` (see 4.2.246) if the spool is terminated by a `Flange`.

4.2.209. Load_transference

A `Load_transference` is a type of `Plant_item_connection` (see 4.2.263) that identifies the purpose or role of the connection as being the transfer of load or force.

4.2.210. Location_in_building

A `Location_in_building` is a type of `Plant_item_location` (see 4.2.272) that is the position of the `Plant_item` (see 4.2.260) relative to the `Building` (see 4.2.14).

4.2.211. Location_in_plant

A `Location_in_plant` is a type of `Plant_item_location` (see 4.2.272) that is the position of the `Plant_item` (see 4.2.260) relative to the `Plant` (see 4.2.258).

4.2.212. Location_in_site

A `Location_in_site` is a type of `Plant_item_location` (see 4.2.272) that is the position of the `Plant_item` (see 4.2.260) relative to the `Site` (see 4.2.313).

4.2.213. Locked_orientation_connection

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A `Locked_orientation_connection` is a type of `Plant_item_connection` (see **4.2.263**) in which two `Plant_item_connector` (see **4.2.265**) objects are in physical contact and there is no relative motion of the connected `Plant_item` (see **4.2.260**) objects with respect to each other.

NOTE A pump housing (containing the impeller and shaft) can be connected to the driver (motor) using a `Locked_orientation_connection`; this would mean that they move in unison.

4.2.214. Lug

The Lug is a type of `Pipe_support` (see **4.2.248**) that consists of a simple plate with a hole to be hanged by. The Lug without a hole is used to support the weight in a manner similar to the Trunnion (see **4.2.363**).

EXAMPLE A spring hanger with or without a hole.

The data associated with a Lug are the following:

— length.

The length specifies the distance between the tip of the Lug and the `location_point`.

4.2.215. Male_end

A `Male_end` is a type of `Piping_connector` (see **4.2.242**) end type that forms a compatible connection with a `Female_end` (see **4.2.116**).

The data associated with a `Male_end` are the following

— `outer_end_preparation`;

— `inner_end_preparation`.

4.2.215.1 outer_end_preparation

The `outer_end_preparation` specifies a description of the outer end of the connector that is necessary to prepare it for welding.

4.2.215.2 inner_end_preparation

The `inner_end_preparation` specifies a description of the inner end of the connector that is necessary to prepare it for welding.

4.2.216. Manufacturing_line

A `Manufacturing_line` is a type of `Plant` (see **4.2.258**) that is defined by the type of product(s) it produces.

4.2.217. Material_specification_selection

A `Material_specification_selection` is the candidate material specifications for piping system design. Each `Material_specification_selection` may be a `Material_specification_subset_reference` (see **4.2.218**).

The data associated with a `Material_specification_selection` are the following:

- description;
- `material_specification_id`;
- `required_or_optional`;
- `selection_id`;
- type.

EXAMPLE The `material_specification_selection` for a piping component would have a of type of "Stainless Steel", a `material_specification_id` of "ASTM (American Society for Testing and Materials) A403", a `selection_id` of "SS A316S", a description of "standard material callout", and be required.

4.2.217.1 description

The description specifies a textual explanation or summary of the selected material specification.

4.2.217.2 material_specification_id

The `material_specification_id` specifies a unique identifier for the material specification selected. `Material_specification_id` is required for each `Material_specification_selection`.

4.2.217.3 required_or_optional

The `required_or_optional` specifies whether the material specification is required or whether its use is optional.

4.2.217.4 selection_id

The `selection_id` specifies a unique identifier for the candidate material specification. `Selection_id` is required for each `Material_specification_selection`.

4.2.217.5 type

The type specifies a designation that classifies a `Material_specification_selection` based on selection criteria.

4.2.218. Material_specification_subset_reference

A `Material_specification_subset_reference` is a type of `Material_specification_selection` (see **4.2.217**) that is the reference parameters required to identify the applicable subset of a `Required_material_description` (see **4.2.299**).

The data associated with a `Material_specification_subset_reference` are the following:

- `subset_id`.

The `subset_id` specifies a unique identifier for the specified subset portion of a `Required_material_description` (see 4.2.299). `Subset_id` is required for each `Material_specification_subset_reference`.

NOTE The subset reference is used when further subdivisions of the material specification selection are provided to allow for a more precise specification of the material.

4.2.219. Mitre_bend_pipe

A `Mitre_bend_pipe` is a type of `Pipe` (see 4.2.236) that is a change in `Pipe` direction accomplished through the use of two or more straight sections of `Pipe` that are beveled and joined on a line bisecting the angle of junction.

NOTE Figure 41 depicts a typical `Mitre_bend_pipe`.

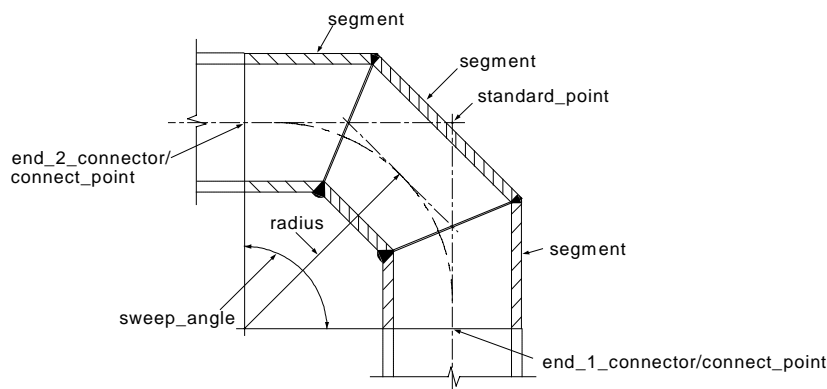


Figure 41 - `Mitre_bend_pipe`

The data associated with a `Mitre_bend_pipe` are the following:

- `number_of_segments`;
- `radius`;
- `sweep_angle`.

4.2.219.1 `number_of_segments`

The `number_of_segments` specifies the number of distinct straight sections of `Pipe` (see 4.2.236) that constitute the `Mitre_bend_pipe`.

4.2.219.2 `radius`

The `radius` specifies the measure of the radius of curvature for a `Mitre_bend_pipe`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.219.3 `sweep_angle`

The `sweep_angle` specifies the angular measure at the centre of curvature from one end of the `Mitre_bend_pipe` to other. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.220. Nipple

A Nipple is a type of Pipe (see 4.2.236) that is commonly acquired in prefabricated lengths and end preparations. Nipples are generally small in size in comparison to other pipes in a piping system.

NOTE Figure 42 depicts a typical Nipple.

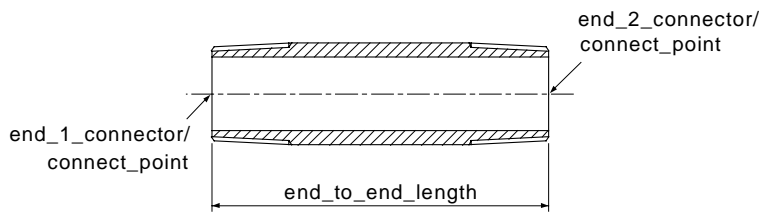


Figure 42 - Nipple

The data associated with a Nipple are the following

— `end_to_end_length`.

The `end_to_end_length` specifies the external distance between the end-one face and the end-two face of the nipple. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.221. Node

A Node is a `Functional_connector` (see 4.2.128) that defines the positional placement for physical components along a Route (see 4.2.302).

4.2.222. Nozzle

A Nozzle is a type of `Plant_item` (see 4.2.260) that is designed to facilitate the connection of another `Plant_item` object to a piece of Equipment (see 4.2.104). A Nozzle is generally permanently affixed to, and protrudes from, the Equipment item and is most commonly used to connect Piping_components (see 4.2.240).

4.2.223. Nut

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A Nut is a type of Bolt_and_nut_component (see 4.2.9) that is used to fasten two or more Plant_items (see 4.2.260) together. The Nut is an internally threaded fastener for Bolts (see 4.2.8) or screws.

The data associated with a Nut are the following:

— nut_type.

The nut_type specifies a classification of the Nut based on its shape characteristics.

EXAMPLE Examples of nut_type designations include hexagon, hexagon_with_washer, and domed_cap.

4.2.224. Offline_instrument

An Offline_instrument is a type of Instrument (see 4.2.188) that monitors the conditions of a system but is not an integral element of the system.

EXAMPLE Local panels, analyzer houses, junction box are examples of Offline_instruments.

4.2.225. Olet

An Olet is a type of Fitting (see 4.2.118) welded onto a hole in the side of a Pipe (see 4.2.236) or other Fitting.

NOTE 1 The primary use of an Olet is for making small branch connections or connecting Instrument (see 4.2.188) lines to Piping_component (see 4.2.240) objects.

NOTE 2 Figure 43 depicts a typical butt-welded latrolet, a kind of Olet.

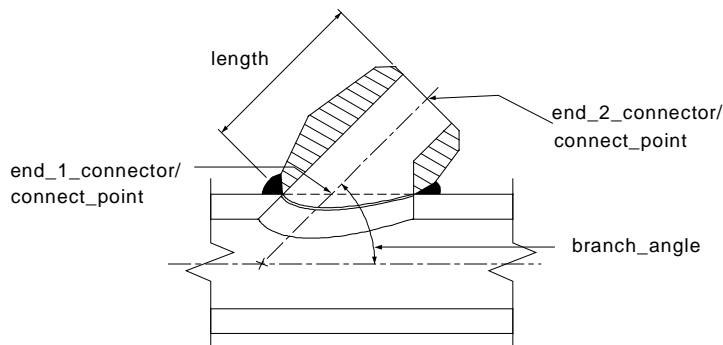


Figure 43 - Olet

EXAMPLE Other kinds of Olets include weldolets, sweepolets, elbowlets, and sockolets.

The data associated with an Olet are the following:

— base_outside_diameter;

— branch_angle;

- end_1_connector;
- end_2_connector;
- length;
- skirt_outside_diameter.

4.2.225.1 base_outside_diameter

The `base_outside_diameter` specifies the external diameter of the Olet at the surface that mates with the straight-run Pipe (see **4.2.236**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.225.2 branch_angle

The `branch_angle` specifies the angle that the branch projects from the straight run. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.225.3 end_1_connector

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) that connects to the main Pipe (see **4.2.236**) or Fitting (see **4.2.118**).

4.2.225.4 end_2_connector

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) that connects to the branch line.

4.2.225.5 length

The `length` specifies the distance between the end-one face and the end-two face at the centreline of the Olet. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.225.6 skirt_outside_diameter

The `skirt_outside_diameter` specifies the maximum external diameter of the Olet (measured perpendicular to the Olet centreline). It may be specified as a single value or as a range of values.

NOTE 1 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

NOTE 2 The sides of an Olet are tapered (not vertical).

4.2.226. Orifice_flange

An `Orifice_flange` is a type of `Flange` (see **4.2.119**) used to assemble an `Inline_instrument` (see **4.2.183**) to meter the flow of liquids or gases in a pipe.

NOTE 1 Orifice_flange objects are used in pairs in conjunction with an Orifice_plate (see 4.2.227).

NOTE 2 Figure 44 depicts a typical Orifice_flange and Orifice_plate (see 4.2.227) configuration.

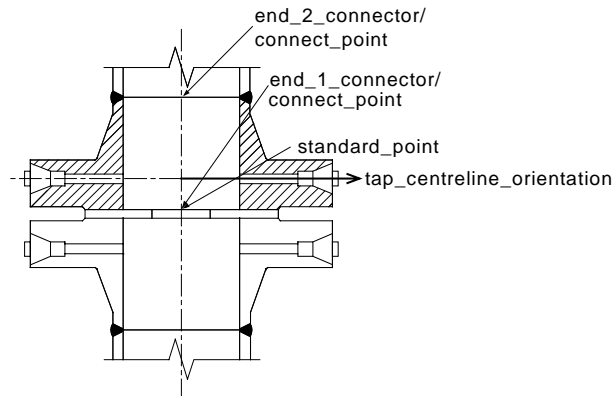


Figure 44 - Orifice_flange

The data associated with an Orifice_flange are the following:

- jacking_screw_orientation;
- tap;
- tap_centreline_orientation.

4.2.226.1 jacking_screw_orientation

The jacking_screw_orientation specifies the angular position of the threaded bolt holes in an Orifice_flange.

NOTE Jacking screws are used to separate the Orifice_flange objects sufficiently to remove or insert the Orifice_plate (see 4.2.227).

4.2.226.2 tap

The tap specifies the Piping_connector (see 4.2.242) designated as the tap.

4.2.226.3 tap_centreline_orientation

The tap_centreline_orientation specifies the orientation of the tap's centreline of the Orifice_flange. It is specified as direction values within the plant coordinate system.

4.2.227. Orifice_plate

An Orifice_plate is a type of Fitting (see 4.2.118) that is a disk with a calibrated hole that is placed in a Pipe (see 4.2.236) to measure flow.

NOTE Figure 45 depicts a typical Orifice_plate.

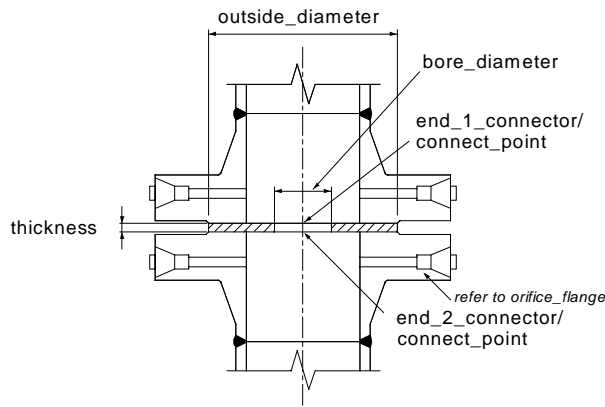


Figure 45 - Orifice_plate

The data associated with an Orifice_plate are the following:

- **beta_ratio**;
- **bore_diameter**;
- **outside_diameter**;
- **thickness**.

4.2.227.1 beta_ratio

The **beta_ratio** is defined as the diameter of the hole in the Orifice_plate divided by the inside diameter of the Pipe (see 4.2.236).

4.2.227.2 bore_diameter

The **bore_diameter** specifies the diameter of the hole in the Orifice_plate. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.227.3 outside_diameter

The **outside_diameter** specifies the external diameter of the Orifice_plate. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.227.4 thickness

The **thickness** specifies the perpendicular distance between the two faces of the Orifice_plate. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.228. Outline_shape

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An **Outline_shape** is a type of **Shape_representation** (see **4.2.309**) that is a 3D spatial volume that corresponds to the bounding surface features of a **Plant_item** (see **4.2.260**).

NOTE Contrast with **Detail_shape** (see **4.2.88**) and **Envelope_shape** (see **4.2.103**). An **Outline_shape** is a simple geometric representation of **Plant_item** (see **4.2.260**); this representation may be called a cartoon. The representation is a more accurate representation of the shape of the **Plant_item** than that provided by an **Envelope_shape**, but not nearly as precise as a **Detailed_shape**.

4.2.229. Outside_and_thickness

An **Outside_and_thickness** is a type of **Piping_size_description** (see **4.2.244**) that describes the size by providing the outside diameter and thickness values.

The data associated with an **Outside_and_thickness** are the following:

- **outside_diameter**;
- **thickness**.

4.2.229.1 outside_diameter

The **outside_diameter** specifies the external diameter of the **Piping_system_component** (see **4.2.250**) or **Piping_connector** (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.229.2 thickness

The **thickness** specifies the minimum distance between the inside and outside piping wall surfaces of the **Piping_system_component** (see **4.2.250**) or **Piping_connector** (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.230. Paddle_blank

A **Paddle_blank** is a type of **Blank** (see **4.2.5**) that reserves space between two **Flange** (see **4.2.119**) objects and blocks the flow of material.

NOTE A **Paddle_blank** has a handle that permits removal or repositioning of the **Paddle_blank**. The name is derived from the fact that the **Paddle_blank** looks like a ping pong paddle.

The data associated with a **Paddle_blank** are the following:

- **paddle_length**;
- **paddle_width**.

4.2.230.1 paddle_length

The `paddle_length` specifies the length of the handle on the `Paddle_blank`. It may be specified as a single value or as a range of values.

NOTE 1 The length is measured from the outside diameter of the Blank (see 4.2.5).

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.230.2 `paddle_width`

The `paddle_width` specifies the width of the handle on the `Paddle_blank`. It may be specified as a single value or as a range of values.

NOTE 1 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

NOTE 2 Figure 46 depicts a typical `Paddle_blank`.

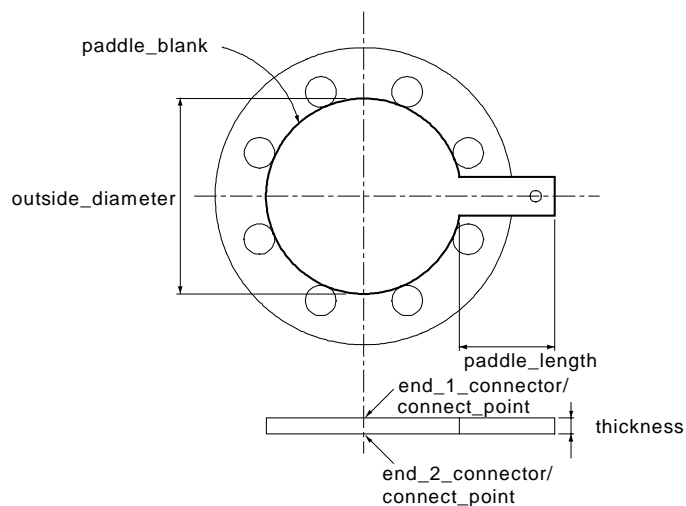


Figure 46 - Paddle_blank

4.2.231. `Paddle_spacer`

A `Paddle_spacer` is a type of `Spacer` (see 4.2.322) that reserves space between two `Flange` (see 4.2.119) objects and permits flow through the `Pipe` (see 4.2.236).

NOTE 1 A `Paddle_spacer` has a handle that permits its removal or repositioning. The inner diameter of the `Paddle_spacer` may be less than the diameter of the `Pipe` (see 4.2.236), thus altering flow.

NOTE 2 Figure 47 depicts a typical `Paddle_spacer`.

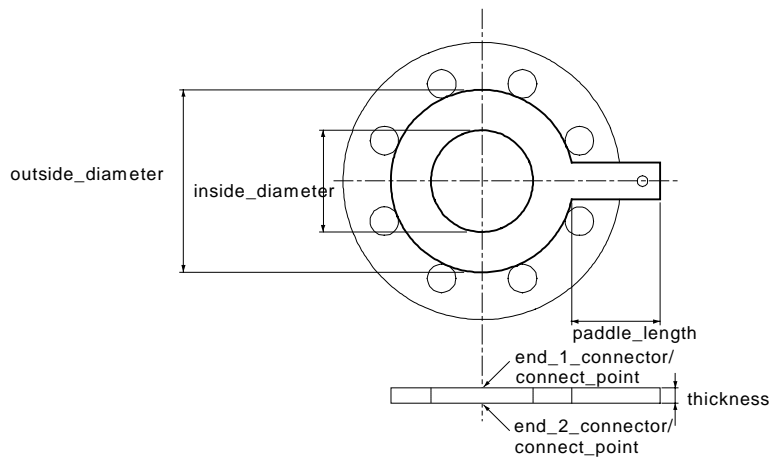


Figure 47 - Paddle_spacer

The data associated with a Paddle_spacer are the following:

- inside_diameter;
- paddle_length;
- paddle_width.

4.2.231.1 inside_diameter

The inside_diameter specifies the diameter of the bore hole through the Paddle_spacer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.231.2 paddle_length

The paddle_length specifies the length of the handle of the Paddle_spacer. It may be specified as a single value or as a range of values.

NOTE 1 The length is measured from the outside diameter of the Paddle_spacer.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.231.3 paddle_width

The paddle_width specifies the width of the handle of the Paddle_spacer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.232. Perforated_cap

A Perforated_cap is a type of Cap (see 4.2.25) with a hole on its closing surface.

NOTE Figure 48 depicts a typical Perforated_cap.

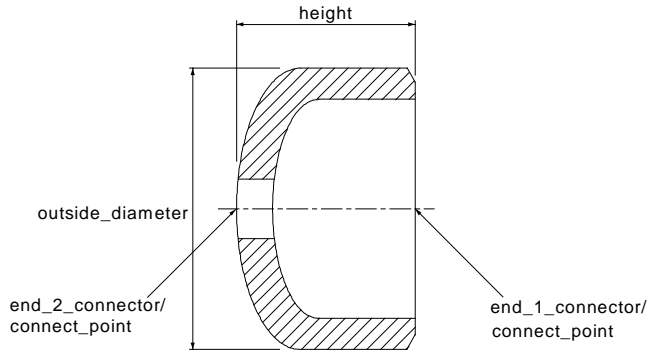


Figure 48 - Perforated_cap

The data associated with a Perforated_cap are the following:

- end_2_connector;
- hole_diameter.

4.2.232.1 end_2_connector

The end_2_connector specifies the Piping_connector (see **4.2.242**) where the inside Pipe (see **4.2.236**) of the jacketed piping connects to the Perforated_cap.

4.2.232.2 hole_diameter

The hole_diameter is the diameter of the hole in the Perforated_cap.

4.2.233. Perforated_plate

A Perforated_plate is a type of Plate (see **4.2.279**) with a hole on its surface.

The data associated with a Perforated_plate are the following:

- end_2_connector;
- hole_diameter.

4.2.233.1 end_2_connector

The end_2_connector specifies the Piping_connector (see **4.2.242**) where the inside Pipe (see **4.2.236**) of the jacketed piping connects to the Perforated_plate.

4.2.233.2 hole_diameter

The hole_diameter is the diameter of the hole in the Perforated_plate.

4.2.234. Physical_connector

A `Physical_connector` is a type of `Plant_item_connector_occurrence` (see **4.2.266**) that represents the physical aspects of the `Plant_item_connector_occurrence`.

4.2.235. Physical_design_view

A `Physical_design_view` is a type of `Plant_item_design_view` (see **4.2.268**) that describes the physical and spatial characteristics of a `Plant_item` (see **4.2.260**).

4.2.236. Pipe

A `Pipe` is a type of `Piping_component` (see **4.2.240**) that is a hollow cylindrical conveyance, with a constant radius for the cross-sectional circle, for directing fluid, vapour, or particulate flow. Each `Pipe` may be one of the following: a `Mitre_bend_pipe` (see **4.2.219**), a `Nipple` (see **4.2.220**), a `Straight_pipe` (see **4.2.332**), or a `Swept_bend_pipe` (see **4.2.349**).

NOTE 1 In most cases, the `Pipe` will conform to the dimensional requirements for nominal pipe size as tabulated in national standards such as American National Standards Institute (ANSI) B36.10 and ANSI B36.19.

NOTE 2 This definition does not exclude tubing and flex hoses from consideration as `Pipe`.

The data associated with a `Pipe` are the following:

- `additional_length`;
- `end_1_connector`;
- `end_2_connector`.

4.2.236.1 additional_length

The `additional_length` specifies the length of `Pipe` that is extended from the designed length of the `Pipe` to allow for installation error.

4.2.236.2 end_1_connector

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) that connects to one end of the `Pipe`.

4.2.236.3 end_2_connector

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) that connects to the other end of the `Pipe`.

4.2.237. Pipe_closure

A Pipe_closure is a type of Fitting (see **4.2.118**) used to close an end of a Piping_component (see **4.2.240**).

Each Pipe_closure may be one of the following: Cap (see **4.2.25**), Plug (see **4.2.280**), or Plate (see **4.2.279**).

NOTE 1 Blind_flange (see 4.2.6) objects also perform the function of closing a Piping_system (see 4.2.249). However, industry terminology treats them differently and they have been defined as separate objects.

NOTE 2 Figure 49 depicts a typical butt-weld Pipe Cap, which is a kind of Pipe_closure.

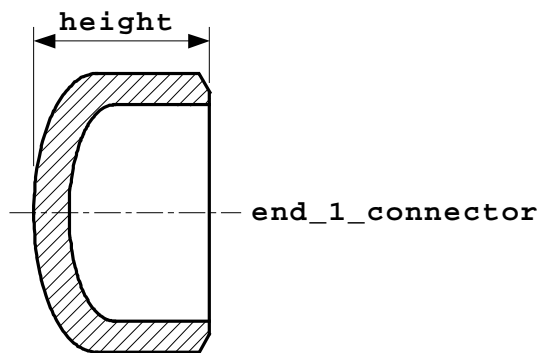


Figure 49 - Butt-weld Pipe Cap

The data associated with a Pipe_closure are the following:

- end_1_connector;
- shape_type.

4.2.237.1 end_1_connector

The end_1_connector specifies the Piping_connector (see **4.2.242**) that connects to the Pipe (see **4.2.236**).

4.2.237.2 shape_type

The shape_type is a type of Shape_representation (see **4.2.309**).

4.2.238. Piping_assembly

A Piping_assembly is an assembled collection of piping Plant_item (see **4.2.260**) objects.

The data associated with a Piping_assembly are the following:

- piping_assembly_number.

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The `piping_assembly_number` specifies an alphanumeric identifier assigned to the `Piping_assembly`.

NOTE A `Piping_assembly` may be defined to meet transportation, fabrication, or erection requirements.

4.2.239. Piping_assembly_assignment

A `Piping_assembly_assignment` is the identification of the `Piping_assembly` (see **4.2.238**) that a `Piping_component` (see **4.2.240**) belongs to.

4.2.240. Piping_component

A `Piping_component` is a type of `Piping_system_component` (see **4.2.250**) whose primary function is the conveyance or control of fluid flow. Each `Piping_component` may be one of the following: a `Fitting` (see **4.2.118**), a `Pipe` (see **4.2.236**), or a `Valve` (see **4.2.367**).

The data associated with a `Piping_component` are the following:

- `pmi_record`;
- `side_connector`;
- `standard_point`;
- `mill_sheet_number`.

4.2.240.1 pmi_record

The `pmi_record` attribute specifies an identifier of the positive material identification document for a `Piping_component`.

4.2.240.2 side_connector

The `side_connector` specifies the `Piping_connector` (see **4.2.242**) that is located between the two ends of the `Piping_component`. There may be more than one `side_connector` for a `Piping_component`.

4.2.240.3 standard_point

The `standard_point` specifies an x, y, z coordinate position defined for the `Piping_component` that will position the `Piping_component` in the Plant (see **4.2.258**) when overlayed on the Node (see **4.2.221**).

4.2.240.4 mill_sheet_number

The `mill_sheet_number` specifies an identifier of the document that comes from the mill providing a record of the raw material that comprises the `Piping_component`.

4.2.241. Piping_component_inspection_record

A Piping_component_inspection_record is a collection of information that captures the result of an evaluation of an observed value for a characteristic of a Piping_component (see 4.2.240) against an expected, designed or prescribed value for that characteristic, as well as information to evaluate the acceptability of the observed value.

The data associated with a Piping_component_inspection_record are the following:

- inspected_property_name;
- inspected_property_tolerance;
- inspected_property_measured_value.

4.2.241.1 inspected_property_name

The inspected_property_name specifies the characteristic for which information is being recorded. The inspected_property_name may be one of the following:

- branch angle;
- flange face type;
- threaded type;
- end preparation shape;
- flange inside diameter dimension;
- flat side orientation;
- hole straddle centreline orientation;
- hub inside diameter dimension;
- hub outside diameter dimension;
- hub weld point diameter dimension;
- hub weld point thickness dimension;
- inside diameter dimension;
- longitudinal welding seam orientation;
- nominal size;
- pipe schedule;
- pressure rating;
- weld point outside diameter dimension;
- weld point thickness dimension;
- weld point inside diameter dimension;
- stand off dimension;
- centreline radius dimension;
- outside diameter dimension;
- thickness dimension;
- swept angle;
- ovality;
- tap orientation;
- paddle orientation.

4.2.241.2 inspected_property_tolerance

The inspected_property_tolerance specifies the acceptable deviation for the measured result of the inspection.

The inspected_property_measured_value specifies the recorded result of the inspection.

4.2.242. Piping_connector

A Piping_connector is a type of Plant_item_connector (see **4.2.265**) that is intended to establish a material flow connection between two Plant_item (see **4.2.260**) objects. Each Piping_connector may be one of the following: a Buttweld (see **4.2.16**), a Clamped (see **4.2.63**), a Flanged (see **4.2.120**), a Pressure_fit (see **4.2.285**), a Socket (see **4.2.319**), a Stub_in (see **4.2.338**), or a Threaded (see **4.2.352**). The end_type of each Piping_connector may be one of the following: a Branch_hole (see **4.2.12**), a Female_end (see **4.2.116**), a Flanged_end (see **4.2.121**), a Flared_end (see **4.2.122**), a Grooved_end (see **4.2.137**), or a Male_end (see **4.2.215**).

The data associated with a Piping_connector are the following:

- connector_flow_direction;
- connector_specification;
- name.

4.2.242.1 connector_flow_direction

The connector_flow_direction specifies an indication of the way process fluid moves past the Plant_item (see **4.2.260**).

4.2.242.2 connector_specification

The connector_specification identifies the specification associated with the Piping_connector. There may be more than one connector_specification for a Piping_connector.

EXAMPLE Examples of the identified connector_specification include insulation specification, end preparation specification, and thread specification.

4.2.242.3 name

The name specifies a textual label given to the Piping_connector.

4.2.243. Piping_connector_service_characteristic

A Piping_connector_service_characteristic is the conditions that the Piping_connector (see **4.2.242**) is designed to withstand.

The data associated with a Piping_connector_service_characteristic are the following:

- design_pressure;
- design_temperature.

4.2.243.1 design_pressure

The `design_pressure` specifies the maximum allowable pressure at the `Piping_connector` (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE 1 This value is normally created as part of doing 3D analysis of the piping system design.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.243.2 design_temperature

The `design_temperature` specifies the maximum allowable temperature at the `Piping_connector` (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE 1 This value is normally created as part of doing 3D analysis of the piping system design.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.244. Piping_size_description

A `Piping_size_description` is used to explain or summarize the physical size of a `Piping_connector` (see **4.2.242**) or `Piping_system_component` (see **4.2.250**), based on a set of dimensional characteristics, and an optional dimensional standard. Each `Piping_size_description` is either an `Inside_and_thickness` (see **4.2.185**), an `Outside_and_thickness` (see **4.2.229**), a `Pressure_class` (see **4.2.284**), or a `Schedule` (see **4.2.303**).

NOTE A `Piping_size_description` is used to specify the size of a `Piping_component` (see **4.2.240**) as a whole (where the size is constant over the extent of the component) or to each individual connector of the `Piping_component` (where the sizes of each different connector differ.)

The data associated with a `Piping_size_description` are the following:

- `dimensional_standard`;
- `ovality_allowance`.

4.2.244.1 dimensional_standard

The `dimensional_standard` specifies a designation for the standard used to dimension the Pipe (see **4.2.236**). The `dimensional_standard` need not be specified for a particular `Piping_size_description`.

EXAMPLE Examples of `dimensional_standard` designations include ANSI and DIN.

4.2.244.2 ovality_allowance

The `ovality_allowance` specifies the acceptable deviation or tolerance allowed in the 'out-of-roundness' of the `Piping_connector` (see **4.2.242**) or `Piping_system_component` (see **4.2.250**). In other words, it specifies how much the `Piping_connector` or `Piping_system_component` can deviate from a perfect circle. The `ovality_allowance` need not be specified for a particular `Piping_size_description`.

4.2.245. Piping_specification

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A Piping_specification is a specification of conditions such as pressure, material, and corrosion allowance that must be met in a Piping_system_line_segment (see **4.2.252**) and may include a list of Piping_component (see **4.2.240**) objects by size range that meet these conditions.

NOTE The Piping_specification is used in Spec-driven design, where the user specifies the size and component type, and the Piping_specification is used to look-up the correct component characteristics. The components listed in the Piping_specification may reference component catalogues.

The data associated with a Piping_specification are the following:

- name;
- owner;
- piping_specification_id;
- service_description.

4.2.245.1 name

The name specifies a textual label given to the Piping_specification.

4.2.245.2 owner

The owner specifies the designation given to the person or organization that created and maintains the Piping_specification.

4.2.245.3 piping_specification_id

The piping_specification_id specifies a unique identifier for the Piping_specification. Piping_specification_id is required for each Piping_specification.

4.2.245.4 service_description

The service_description specifies a textual explanation or summary of the process stream conditions that are supported by the Plant_item (see **4.2.260**) objects described in the Piping_specification.

4.2.246. Piping_spool

A Piping_spool is a collection of piping Plant_item (see **4.2.260**) objects.

A Piping_spool is an assembly of Piping_components (see **4.2.240**) and applicable Plant_items (see **4.2.260**) such as Piping_support (see **4.2.248**) attachment to be shop fabricated and physically connected into one item.

The data associated with a Piping_spool are the following:

- tag_number;
- piping_type;

— temporary_flag.

4.2.246.1 tag_number

The tag_number is a unique identification of the Piping_spool.

4.2.246.2 piping_type

The piping_type specifies whether a Piping_spool is comprised of single or jacketed piping. The value of piping_type is one of the following:

— jacketed

— single

4.2.246.2.1 jacketed

Jacketed Piping_spool has inner piping and outer piping.

4.2.246.2.2 single

A single Piping_spool has no jacket.

4.2.246.3 temporary_flag

The temporary flag specifies whether the Piping_spool is a temporary spool, usually having flanged connectors, that is to be replaced with a different Piping_component (see **4.2.240**) at some point in the construction of the Plant (see **4.2.258**).

4.2.247. Piping_spool_inspection_record

A Piping_spool_inspection_record is a collection of information that captures the result of an evaluation of an observed value for a characteristic of a Piping_spool (see **4.2.246**) against an expected, designed or prescribed value for that characteristic, as well as information to evaluate the acceptability of the observed value.

The data associated with a Piping_spool_inspection_record are the following

— inspected_preproperty_name;

— inspected_property_tolerance;

— inspected_property_measured_value.

4.2.247.1 inspected_property_name

The inspected_property_name specifies the characteristic for which information is being recorded. The inspected_property_name may be one of the following:

— piping spool configuration inspection;

— pressure test;

— leak test;

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- visual examination;
- surface painting;
- marking;
- packed figure;
- end protection;
- high voltage for pin hole detective;
- lining thickness.

4.2.247.2 inspected_property_tolerance

The inspected_property_tolerance specifies the acceptable deviation for the measured result of the inspection.

4.2.247.3 inspected_property_measured_value

The inspected_property_measured_value specifies the recorded result of the inspection.

4.2.248. Piping_support

A Piping_support is a type of Support_component (see **4.2.343**) that is fabricated onto the pipe, and supports the Piping_spool (see **4.2.246**) when it is installed into the Plant (see **4.2.258**).

The data associated with a Piping_support are the following:

- end_1_connector;
- location_point;
- orientation.

4.2.248.1 end_1_connector

The end_1_connector specifies the Piping_connector (see **4.2.242**) on the Piping_support to the pipe.

4.2.248.2 location_point

The location_point is a standard point on Piping_component (see **4.2.240**) at which the Piping_support is attached.

EXAMPLE When a Base_elbow_support (see 4.2.3) is attached to an Elbow (see 4.2.98), the location_point is the centre of the Elbow, where the centrelines of two arms of Elbow intersect.

When a Base_line_support (see 4.2.4) is attached to a Straight_pipe (see 4.2.332), the location_point is the intersection of the centrelines of the Straight_pipe and the main body of the Base_line_support.

4.2.248.3 orientation

The orientation specifies a unit vector in the direction of the main part of the Piping_support. The vector defines the layout of the Piping_support.

4.2.248.4 piping support types

Necessary information for piping shop fabrication: type, location point, orientation and dimensional parameters. Types of Piping_supports include: Base_elbow_support (Adjustable and Non-adjustable) (see 4.2.3), Base_line_support (see 4.2.4), Dummy_leg (see 4.2.92), Eccentric_base_elbow_support (see 4.2.93), Lug (see 4.2.214), Shoe (see 4.2.312), Stopper (see 4.2.331), and Trunnion (see 4.2.363).

4.2.249. Piping_system

A Piping_system is a type of Plant_system (see 4.2.276) that is a system of interconnected Plant_item (see 4.2.260) objects that convey fluid, vapour, or particulate flow throughout a plant. Each Piping_system may be a Line_less_piping_system (see 4.2.199).

EXAMPLE Methods of flow conveyance through the Piping_system include mechanical, gravitational, and electromagnetic induction.

The data associated with a Piping_system are the following:

- code;
- description.

4.2.249.1 code

The code specifies the name of the specification that the Piping_system needs to conform to.

4.2.249.2 description

The description specifies a textual explanation or summary of the Piping_system.

4.2.250. Piping_system_component

A Piping_system_component is a type of Plant_item (see 4.2.260) that is a constituent element of a Piping_system (see 4.2.249). Each Piping_system_component may be one of the following: an Inline_equipment (see 4.2.182), an Inline_instrument (see 4.2.183), a Piping_component (see 4.2.240), a Process_ducting (see 4.2.286), or a Specialty_item (see 4.2.324).

The data associated with a Piping_system_component are the following:

- coating_reference;
- corrosion_allowance;
- heat_tracing_type;
- lining.

4.2.250.1 coating_reference

The `coating_reference` specifies a reference to the specification of the substances used to coat the surfaces of a `Piping_system_component`. For a given `Piping_system_component`, the value of this attribute overrides any global specification.

4.2.250.2 corrosion_allowance

The `corrosion_allowance` specifies the depth that corrosion may encroach below the surface of a `Piping_system_component` before action is required. For a given `Piping_system_component`, the value of this attribute overrides any global specification. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values. The depth of the corrosion may vary over the extent of the `Piping_component` (see **4.2.240**).

4.2.250.3 heat_tracing_type

The `heat_tracing_type` specifies the means utilized to impart a temperature increase to the `Piping_system_component` by an external wrapping or coiling. For a given `Piping_system_component`, the value of this attribute overrides any global specification.

NOTE Types may include electrical or steam.

4.2.250.4 lining

The `lining` specifies a description of the substances used to line the internal surfaces of a `Piping_system_component`.

4.2.251. Piping_system_line

A `Piping_system_line` is a logical component of a `Piping_system` (see **4.2.249**) and is composed of a collection of interconnected `Piping_system_line_segment` (see **4.2.252**) objects.

The data associated with a `Piping_system_line` are the following:

— `line_number`;

— `P_and_I_reference`.

4.2.251.1 line_number

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

EXAMPLE A1A-PX-100-4-150, is a coded number that identifies the `Piping_system_line` and the main design criteria - specification = A1A, process = PX, line number = 100, line size = 4, and pressure rating = 150.

4.2.251.2 P_and_I_reference

The `P_and_I` reference specifies the piping and instrumentation diagram that depicts the `Piping_system_line`.

4.2.252. Piping_system_line_segment

A `Piping_system_line_segment` is an element of a `Piping_system_line` (see **4.2.251**). A `Piping_system_line_segment` terminates at a functional `Plant_item_connector` (see **4.2.265**), a tap into a `Piping_system_line`, a point where the stream diverges or converges, a vent, or a drain.

The data associated with a `Piping_system_line_segment` are the following:

- `coating_reference`;
- `corrosion_allowance`;
- `design_pressure`;
- `design_temperature`;
- `elevation`;
- `heat_tracing_type`;
- `line_number`;
- `line_size`.

4.2.252.1 coating_reference

The `coating_reference` specifies a reference to the specification that details the coating requirements of the `Piping_component` (see **4.2.240**) objects associated with the `Piping_system_line` (see **4.2.251**).

4.2.252.2 corrosion_allowance

The `corrosion_allowance` specifies the depth that corrosion may encroach below the surface of components on a `Piping_system_line_segment` before action is required. For a given `Piping_system_component` (see **4.2.250**), the value of this attribute overrides any global specification.

4.2.252.3 design_pressure

The `design_pressure` specifies the requirement for maximum allowable pressure of the `Piping_component` (see **4.2.240**) objects associated with the `Piping_system_line` (see **4.2.251**).

4.2.252.4 design_temperature

The `design_temperature` specifies the requirement for maximum allowable temperature of the `Piping_component` (see **4.2.240**) objects associated with the `Piping_system_line` (see **4.2.251**).

4.2.252.5 elevation

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The elevation specifies the distance above sea level that the piping assigned to the line should exist.

4.2.252.6 heat_tracing_type

The `heat_tracing_type` specifies the heating method used to maintain temperature in the `Piping_system_line` (see **4.2.251**).

EXAMPLE Heating method designations include steam tracing and electrical.

4.2.252.7 line_number

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` (see **4.2.251**) and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

4.2.252.8 line_size

The `line_size` specifies the intended diameter of the piping to be selected to satisfy the `Piping_system_line` (see **4.2.251**). The `line_size` need not be specified for a particular `Piping_system_line_segment` where the `Piping_system_line_segment` corresponds to one `Piping_system_component` (see **4.2.250**).

NOTE When the `line_size` is not specified, it is either ambiguous due to the nature of the `Piping_system_component` (see **4.2.250**) such as a Reducer (see **4.2.292**), or derivable from one or more of the connecting `Piping_system_line_segments`.

4.2.253. Piping_system_line_segment_termination

A `Piping_system_line_segment_termination` is one of two logical end-points of a `Piping_system_line_segment` (see **4.2.252**). Each `Piping_system_line_segment_termination` is either: a `Line_branch_termination` (see **4.2.198**), a `Line_to_line_termination` (see **4.2.207**), a `Line_plant_item_termination` (see **4.2.205**), or `Piping_system_line_termination` (see **4.2.254**).

NOTE `Piping_system_line` (see **4.2.251**) objects are composed of individual `Piping_system_line_segment` (see **4.2.252**) objects. `Piping_system_line_segment` objects are connected through `Piping_system_line_segment_termination` objects.

The data associated with a `Piping_system_line_segment_termination` are the following:

- `flow_direction`;
- `line_number`.

4.2.253.1 flow_direction

The `flow_direction` specifies the direction of material flow at the `Piping_system_line_segment_termination`. The value of the `flow_direction` attribute shall be one of the following:

- both;

- in;
- not_specified;
- out.

4.2.253.1.1 both: material may flow in either direction past the Piping_system_line_segment_termination.

4.2.253.1.2 in: material flows into the line segment past the Piping_system_line_segment_termination.

4.2.253.1.3 not_specified: the direction of material flow past the Piping_system_line_segment_termination is not specified.

4.2.253.1.4 out: material flows out of the line segment past the Piping_system_line_segment_termination.

4.2.253.2 line_number

The line_number specifies an alphanumeric identifier assigned to the Piping_system_line (see **4.2.251**) and can be used to uniquely define the Piping_system_line. Line_number is required for each Piping_system_line.

4.2.254. Piping_system_line_termination

A Piping_system_line_termination is a type of Piping_system_line_segment_termination (see **4.2.253**) that begins or ends a Piping_system_line (see **4.2.251**).

The data associated with a Piping_system_line_termination are the following:

- location;
- position_on_pipe;
- start_or_end.

4.2.254.1 location

The location specifies the relative distance in the X, Y, Z directions of the position of the end of the Piping_system_line (see **4.2.251**), from the plant origin. The location position may also be defined by where it connects to an upstream piece of Equipment (see **4.2.104**) or Piping_system_line.

4.2.254.2 position_on_pipe

The position_on_pipe specifies an indicator of the relationship between the point and the Piping_component (see **4.2.240**) that will eventually satisfy it.

NOTE If the indicator is not specified, the assumed value is Centre Of Pipe (COP).

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EXAMPLE A position_on_pipe may be COP or BOP indicating that the location of the Piping_system_line_termination location is on the centre or bottom of the pipe.

4.2.254.3 start_or_end

The start_or_end specifies an enumerated value that defines the side of the pipe on which the line termination lies. A value of 'start' indicates the line termination is on the upstream end, and a value of 'end' indicates that the line termination is on the downstream end.

4.2.255. Plain_washer

A Plain_washer is a type of Washer (see **4.2.369**). The shape of the Plain_washer is a thin flat ring.

The data associated with a Plain_washer are the following:

- thickness;
- outside_diameter.

4.2.255.1 thickness

The thickness specifies the distance between two faces of the Plain_washer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.255.2 outside_diameter

The outside_diameter specifies the external diameter of the Plain_washer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.256. Planned_physical_plant

A Planned_physical_plant is the set of physical and spatial characteristics that a Plant (see **4.2.258**) can have, including siting, location, and orientation.

NOTE A Planned_physical_plant can also be the basis for locating other items such as Plant_item (see **4.2.260**) objects, Plant_item_location (see **4.2.272**).

4.2.257. Planned_physical_plant_item

A Planned_physical_plant_item is a type of Plant_item_instance (see **4.2.269**) that is intended to have physical existence in the real world and that has been used or instanced in a design.

NOTE Additionally, a Planned_physical_plant_item is always intended to be 'physical' as opposed to purely volumetric. In general, this means that anything that would pose a hard physical impediment to a kick (e.g., a pump) is a physical item, and anything that does not (e.g., an escape route or the water in a cooling pond) is purely volumetric.

The data associated with a `Planned_physical_plant_item` are the following:

- `stock_code`;
- `global_unambiguous_identifier`.

4.2.257.1 `stock_code`

The `stock_code` is an identifier of an in-stock item that may be necessary to be included in a piece of shop fabricated piping.

4.2.257.2 `global_unambiguous_identifier`

A `global_unambiguous_identifier` is a unique, persistent identifier of the item consisting of a concatenation of a `company_id` and a `local_id` generated by the company.

4.2.257.2.1 `company_id`

The `company_id` specifies a unique identifier for the company that created the data. The string is left justified and blank filled.

4.2.257.2.2 `local_id`

The `local_id` specifies a persistent identifier which uniquely identifies this item throughout the company. It is assigned at the time the item definition is created. The string is left justified and blank filled.

4.2.258. Plant

A Plant is a portion of an installation (or the entire installation) required to operate to produce products. Each Plant may be one of the following: a `Manufacturing_line` (see **4.2.216**), a `Train` (see **4.2.356**), or a `Unit` (see **4.2.365**). The z-axis of the local coordinate system of the Plant shall be considered the elevation of the coordinate space.

NOTE `Manufacturing_lines` (see **4.2.216**), `Trains` (see **4.2.356**), and `Units` (see **4.2.365**), may be considered as sub-plants of a Plant because they perform all of the same functions as a plant and may be considered as a plant. They are distinct, they produce products based on input resources, and they are (relatively) independent of other plant/sub-plants. `Trains`, for instance, provide duplicate functionality of one another in case of failure.

The data associated with a Plant are the following:

- `definition_coordinate_system`;
- `description`;
- `length_between_perpendiculars`;
- `name`;
- `operator`;

- owners;
- plant_id;
- plant_type.

4.2.258.1 definition_coordinate_system

The `definition_coordinate_system` is the origin and axes of the Plant that serve as the basis for the location and orientation of `Plant_items` (see **4.2.260**) and subplants in the Plant.

4.2.258.2 description

The description specifies a textual explanation or summary of the Plant. The description need not be specified for a particular Plant. There may be more than one description for a Plant.

4.2.258.3 length_between_perpendiculars

`Length_between_perpendiculars` specifies the distance between perpendicular elements in the model. This is used to specify layout grids in a model, and to specify the horizontal, longitudinal distance between the aft and forward perpendiculars in ship models.

EXAMPLE Column spacing in a Plant is an example of layout grids in a model.

4.2.258.4 name

The name specifies a textual label given to the Plant.

4.2.258.5 operator

The operator specifies the name of the organization(s) responsible for the operation of the Plant. For a given Plant, the operator need not be specified.

4.2.258.6 owners

The owners specifies the name of the organization(s) that owns the Plant. For a given Plant, the owners need not be specified.

4.2.258.7 plant_id

The `plant_id` specifies a unique identifier for the Plant. `Plant_id` is required for each Plant.

4.2.258.8 plant_type

`Plant_type` specifies a designation that classifies a Plant based on its physical and functional characteristics.

EXAMPLE Examples of `plant_type` include: beverage plant, pharmaceutical plant, power plant, offshore oil facility, commercial ship, and military ship.

4.2.259. Plant_csg_shape_representation

A Plant_csg_shape_representation is a type of Shape_representation (see 4.2.309). This requirement is for a "pure csg" shape, and a complex csg will be accomplished using the hybrid representation.

4.2.260. Plant_item

A Plant_item is an identifiable item that has a shape and that may be used as a component of the Plant (see 4.2.258). The Plant_item need not be a physical item, but may be an allocation of space reserved for a purpose. Each Plant_item is either: a Plant_item_definition (see 4.2.267) or a Plant_item_instance (see 4.2.269). Each Plant_item may be one of the following: a Ducting_component (see 4.2.90), an Electrical_component (see 4.2.99), an Equipment (see 4.2.104), an Hvac_component (see 4.2.145), an Instrumentation_and_control_component (see 4.2.189), an Insulation (see 4.2.191), a Piping_system_component (see 4.2.250), a Structural_component (see 4.2.335), or a Support_component (see 4.2.343).

The data associated with a Plant_item are the following:

- description;
- name;
- plant_item_id;
- status;
- type.

4.2.260.1 description

The description specifies a textual explanation or summary of the Plant_item.

4.2.260.2 name

The name specifies a textual label given to the Plant_item.

4.2.260.3 plant_item_id

The plant_item_id specifies a unique identifier for the Plant_item. Plant_item_id is required for each Plant_item.

4.2.260.4 status

The status specifies the state of the Plant_item within the life cycle of the Plant (see 4.2.258).

4.2.260.5 type

The type specifies a designation that classifies a Plant_item based on its physical and functional characteristics.

4.2.261. Plant_item_centreline

A `Plant_item_centreline` is a type of `Reference_geometry` (see **4.2.295**) that is a centre of symmetry of an aspect of the shape of the `Plant_item` (see **4.2.260**).

4.2.262. Plant_item_collection

A `Plant_item_collection` is an association that indicates that a component `Plant_item` (see **4.2.260**) is part of an aggregate `Plant_item`. Each `Plant_item_collection` may be a `Connected_collection` (see **4.2.70**). Each `Plant_item_collection` may be a `Hierarchically_organized_collection` (see **4.2.141**).

EXAMPLE A `Plant_item_collection` may be defined for a kit, where the members are not connected, or for an assembly, where the members are connected. Collections that are not hierarchically organized may be physical systems where a single component plays a role in multiple systems, such as a gauge.

The data associated with a `Plant_item_collection` are the following:

- `location_and_orientation`;
- `usage_type`.

4.2.262.1 location_and_orientation

The `location_and_orientation` specifies the relative position and orientation of the `Plant_item` (see **4.2.260**) within the `Plant_item_collection`. The `location_and_orientation` need not be specified for a particular `Plant_item_collection`.

4.2.262.2 usage_type

The `usage_type` specifies the purpose for the association defined by the `Plant_item_collection`. The `usage_type` may be one of the following:

- BOM;
- compound bend pipe;
- source identification;
- assembly-component.

4.2.262.2.1 BOM: The value BOM specifies that the `Plant_item_collection` is being used to collect `Plant_items` (see **4.2.260**) that represent a bill of materials for the `Plant_item` identified as the group.

4.2.262.2.2 compound bend pipe: The value compound bend pipe specifies that the `Plant_item_collection` is being used to collect `Plant_items` (see **4.2.260**) that are Pipes (see **4.2.236**) to create a `Compound_bend_pipe` (see **4.2.65**). If the `usage_type` is `Compound_bend_pipe`, the group `Plant_item` shall be a `Compound_bend_pipe`, and the element `Plant_items` are either `Straight_pipe` (see **4.2.332**), `Swept_bend_pipe` (see **4.2.349**), or `Mitre_bend_pipe` (see **4.2.219**).

4.2.262.2.3 source identification: The value source identification specifies that the Plant_item_collection is being used to collect different suppliers' source Plant_items (see 4.2.260) identified by the element for a particular Plant_item identified by the group.

4.2.262.2.4 assembly-component: The value assembly-component specifies that the Plant_item_collection is being used to collect immediate component Plant_items (see 4.2.260) in an assembly Plant_item. The group identifies the Plant_item that is the assembly and the element identifies the Plant_item that is the group

4.2.263. Plant_item_connection

A Plant_item_connection is a linkage between two or more Plant_item_connector (see 4.2.265) objects. The joining conditions may be specified for the connection. Each Plant_item_connection is either a Connection_definition (see 4.2.72) or a Plant_item_connection_occurrence (see 4.2.264). Each Plant_item_connection is either a Flexible_connection (see 4.2.123) or a Locked_orientation_connection (see 4.2.213). Each Plant_item_connection may be an Electricity_transference (see 4.2.102). Each Plant_item_connection may be a Fluid_transference (see 4.2.124). Each Plant_item_connection may be a Load_transference (see 4.2.209). Each Plant_item_connection can have many function types, for the purpose of describing the role that the connection plays in the Plant (see 4.2.258).

NOTE 1 In most cases, such as Piping_components (see 4.2.240), a Plant_item_connection links only two Plant_item_connector (see 4.2.265) objects.

NOTE 2 The term connection does not imply functional continuity beyond the connectors involved in the connection.

The data associated with a Plant_item_connection are the following:

- connection_commitment_target;
- connection_id;
- description;
- shop_joint.

4.2.263.1 connection_commitment_target

The connection_commitment_target specifies when in the life_cycle phases of the Plant_system (see 4.2.276) that a connection is actually made.

EXAMPLE Examples of connection_commitment_targets include fabrication, field-fit, commissioning, or others.

4.2.263.2 connection_id

The connection_id specifies a unique identifier for the Plant_item_connection. Connection_id is required for each Plant_item_connection.

4.2.263.3 description

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The description specifies the textual explanation or summary of the function of the `Plant_item_connection`.

4.2.263.4 shop_joint

The `shop_joint` specifies that the connection is made in the shop.

4.2.264. Plant_item_connection_occurrence

A `Plant_item_connection_occurrence` is a type of `Plant_item_connection` (see **4.2.263**) that involves a physical linkage between two or more `Plant_item_connector_occurrence` (see **4.2.266**) objects.

The data associated with a `Plant_item_connection_occurrence` are the following:

- `connection_definition`;
- `field_fit`.

4.2.264.1 connection_definition

The `connection_definition` specifies the `connection_id` of the `Connection_definition` (see **4.2.72**) which specifies the defined characteristics of the `Plant_item_connection_occurrence`.

4.2.264.2 field_fit

The `field_fit` specifies that the `Plant_item_connection_occurrence` is to be made by adjusting the length of Pipe (see **4.2.236**) to make the connection properly.

4.2.265. Plant_item_connector

A `Plant_item_connector` is a feature of a `Plant_item` (see **4.2.260**) that is designed to connect to a connector on another `Plant_item`. Each `Plant_item_connector` may have specified its design type as one of the following: an `Electrical_connector` (see **4.2.100**), a `Piping_connector` (see **4.2.242**), or a `Structural_load_connector` (see **4.2.336**). Each `Plant_item_connector` is either a `Connector_definition` (see **4.2.75**) (a definitional type) or a `Plant_item_connector_occurrence` (see **4.2.266**) (a specified type).

NOTE The definitional type is used as the connector definition for a `Plant_item_definition` (see **4.2.267**). A specified type is used for a `Plant_item_instance` (see **4.2.269**).

The data associated with a `Plant_item_connector` are the following:

- `connect_point`;
- `plant_item_connector_id`.

4.2.265.1 connect_point

The `connect_point` specifies a point on or in the connector where the terminal interface with another connector occurs.

4.2.265.2 `plant_item_connector_id`

The `plant_item_connector_id` specifies a unique identifier for the `Plant_item_connector`. `Plant_item_connector_id` is required for each `Plant_item_connector`.

4.2.266. `Plant_item_connector_occurrence`

A `Plant_item_connector_occurrence` is a type of `Plant_item_connector` (see **4.2.265**) that is a physical feature of a `Plant_item` (see **4.2.260**) that connects or mates with a like type of connector on another `Plant_item`. Each `Plant_item_connector_occurrence` is either: a `Functional_connector` (see **4.2.128**) or a `Physical_connector` (see **4.2.234**).

The data associated with a `Plant_item_connector_occurrence` are the following:

- `connector_definition`;
- `orientation`.

4.2.266.1 `connector_definition`

The `connector_definition` specifies the `connector_id` of the `Connector_definition` (see **4.2.75**) which specifies the defined characteristics of the `Plant_item_connector_occurrence`.

4.2.266.2 `orientation`

The `orientation` specifies the relative orientation of the `Plant_item_connector_occurrence` to a defined point on the `Plant_item` (see **4.2.260**).

4.2.267. `Plant_item_definition`

A `Plant_item_definition` is a type of `Plant_item` (see **4.2.260**) that has been designed to some level of completeness, but has not been used as the design for physical `Plant_item` objects.

4.2.268. `Plant_item_design_view`

A `Plant_item_design_view` is the collection of information about a `Plant_item` (see **4.2.260**) that is associated with a particular design phase. Each `Plant_item_design_view` is either: a `Functional_design_view` (see **4.2.131**) or a `Physical_design_view` (see **4.2.235**).

4.2.269. `Plant_item_instance`

A `Plant_item_instance` is a planned type of `Plant_item` (see **4.2.260**), as instanced in a spatial, functional or other design. Each `Plant_item_instance` is either a `Planned_physical_plant_item` (see **4.2.257**) or a `Plant_volume` (see **4.2.278**).

NOTE A `Plant_item_instance` is created through the use or instancing of a `Plant_item_definition` (see **4.2.267**) by placing it in a design.

4.2.270. Plant_item_interference

A `Plant_item_interference` is where the spatial volume occupied by a `Plant_item` (see **4.2.260**) overlaps the space occupied by one or more `Plant_item` objects.

The data associated with a `Plant_item_interference` are the following:

- `interference_id`;
- `type`.

4.2.270.1 interference_id

The `interference_id` specifies an identifier for the `Plant_item_interference`.

4.2.270.2 type

The `type` specifies the classification assigned to the `Plant_item_interference` based on the criticality of the clash.

NOTE The criticality is an assessment of the importance or significance of the clash for a particular project. The values are project dependent.

4.2.271. Plant_item_interference_status

A `Plant_item_interference_status` is a designation indicating the state of resolution of an identified interference.

The data associated with a `Plant_item_interference_status` are the following:

- `assessor`;
- `first_item`;
- `second_item`;
- `status`.

4.2.271.1 assessor

The `assessor` specifies the individual or organization assigned the responsibility for resolving the `Plant_item_interference` (see **4.2.270**).

4.2.271.2 first_item

The `first_item` specifies the `plant_item_id` of one of the `Plant_items` (see **4.2.260**) that is interfering.

4.2.271.3 second_item

The `second_item` specifies the `plant_item_id` of one of the `Plant_items` (see **4.2.260**) that is interfering.

4.2.271.4 status

The status specifies a designation indicating the state of resolution of an identified `Plant_item_interference` (see **4.2.270**).

4.2.272. Plant_item_location

A `Plant_item_location` is the position of the `Plant_item` (see **4.2.260**) within a `Plant` (see **4.2.258**). The position of a `Plant_item` is specified as the transformation (translation and rotation) of a point and axes on the `Plant_item` to a point and axes in the destination coordinate system. Each `Plant_item_location` is either a `Location_in_building` (see **4.2.210**), a `Location_in_plant` (see **4.2.211**), a `Location_in_site` (see **4.2.212**), or a `Relative_item_location` (see **4.2.298**).

The data associated with a `Plant_item_location` are the following:

- `location_and_orientation`;
- `location_id`.

4.2.272.1 location_and_orientation

The `location_and_orientation` specifies the relative position and orientation of the `Plant_item` (see **4.2.260**) within the `Plant` (see **4.2.258**).

4.2.272.2 location_id

The `location_id` specifies a unique identifier for the `Plant_item_location`.

4.2.273. Plant_item_shape

A `Plant_item_shape` is the volumetric representation of a `Plant_item` (see **4.2.260**). Each `Plant_item_shape` may be one of the following: a `Detail_shape` (see **4.2.88**), an `Envelope_shape` (see **4.2.103**), or an `Outline_shape` (see **4.2.228**). The z-axis of the local coordinate system of the `Plant_item_shape` shall be considered the elevation of the coordinate space.

The data associated with a `Plant_item_shape` are the following:

- `clash_detection_class`;
- `origin`.

4.2.273.1 clash_detection_class

The `clash_detection_class` specifies a designation that classifies a `Plant_item_shape` for the purposes of interference checking. The value of the `clash_detection_class` attribute shall be one of the following:

- `hard`;
- `ignore`;

— soft.

4.2.273.1.1 hard: the Plant_item_shape is used for clash detection and indicates that the shape cannot occupy the same physical space with another hard shape.

4.2.273.1.2 ignore: the Plant_item_shape is not used for clash detection.

4.2.273.1.3 soft: the Plant_item_shape is used for clash detection and indicates that the shape can occupy the same space with another soft shape and, depending on the circumstances, may occupy the same space as a hard object.

NOTE See Table 1. Table 1 represents a comparison between the clash_detection_class designations for two Plant_item_shapes and indicates whether the resulting interference would be designated as hard clash, soft clash, or no clash. A hard clash refers to an interference between two Plant_item_shapes whose clash_detection_class is hard. A soft clash refers to an interference between two Plant_item_shapes where at least one of the Plant_item_shapes has a clash_detection_class of soft. A no clash refers to an interference between two Plant_item_shapes where at least one of the Plant_item_shapes has a clash_detection_class of ignore.

Table 1 — Plant_item_shape interference clash detection

	Hard	Ignore	Soft
Hard	hard clash	no clash	soft clash
Ignore	no clash	no clash	no clash
Soft	soft clash	no clash	soft clash

4.2.273.2 origin

The origin specifies the locating point for the geometric shape of a Plant_item (see **4.2.260**).

4.2.274. Plant_item_weight

A Plant_item_weight is an estimate or the measure of the force experienced by the Plant_item (see **4.2.260**) as a result of the earth's gravity.

NOTE Before the Plant_item (see **4.2.260**) actually exists, weight is simply an estimate. The actual weight may be provided if the Plant_item does exist and has been measured.

The data associated with a Plant_item_weight are the following:

- centre_of_gravity;
- weight_state;
- weight_value.

4.2.274.1 centre_of_gravity

The `centre_of_gravity` specifies the point where the entire weight of a `Plant_item` (see **4.2.260**) may be considered as concentrated so that if supported at this point the `Plant_item` would remain in equilibrium in any position.

4.2.274.2 weight_state

The `weight_state` specifies a designation of the condition of the `Plant_item` (see **4.2.260**) that corresponds to the `Plant_item_weight`.

NOTE The value of the `weight_state` may be one of a set of predefined values or may be user supplied.

The value of the `weight_state` attribute may be one of the following:

- empty;
- full;
- operating;
- shipping;
- test;
- weight value.

4.2.274.2.1 empty: the `Plant_item` (see **4.2.260**) does not contain any process materials.

4.2.274.2.2 full: the `Plant_item` (see **4.2.260**) contains maximum amount of process materials.

4.2.274.2.3 operating: the `Plant_item` (see **4.2.260**) is in normal operating conditions.

4.2.274.2.4 shipping: the `Plant_item` (see **4.2.260**) and its transportation and packing materials are included.

4.2.274.2.5 test: the `Plant_item` (see **4.2.260**) is for purposes of structural load calculations.

4.2.274.3 weight_value

The `weight_value` specifies a measure of the force experienced by the `Plant_item` (see **4.2.260**) as a result of the earth's gravity.

4.2.275. Plant_process_capability

A `Plant_process_capability` is a functional behaviour that can be executed by the `Plant` (see **4.2.258**).

The data associated with a `Plant_process_capability` are the following:

- `production_capacity`;
- `production_type`.

EXAMPLE A Plant (see **4.2.258**) with a production_type of POWER may produce power at a production_capacity of 500 million kilowatts per hour. If this process capability is provided by a combination of a Piping_system (see **4.2.249**) (for steam, for example) and an Electrical_system (see **4.2.101**), both of these systems can be combined as a subplant; the subplant has the process capability and is part of a plant.

4.2.275.1 production_capacity

The production_capacity specifies the rated output of the Plant (see **4.2.258**) with respect to a Plant_process_capability.

4.2.275.2 production_type

The production_type specifies a designation that classifies the Plant (see **4.2.258**) based on the products it produces.

4.2.276. Plant_system

A Plant_system is a combination of Plant_item (see **4.2.260**) objects that perform a function required for the Plant (see **4.2.258**) to operate to produce products. Each Plant_system may be one of the following: an Electrical_system (see **4.2.101**), a Ducting_system (see **4.2.91**), an Instrumentation_and_control_system (see **4.2.190**), a Piping_system (see **4.2.249**), or a Structural_system (see **4.2.337**).

The data associated with a Plant_system are the following:

- name;
- plant_system_id;
- service_description;
- approval_state.

4.2.276.1 name

The name specifies a textual label given to the Plant_system.

4.2.276.2 plant_system_id

The plant_system_id specifies a unique identifier for the Plant_system. Plant_system_id is required for each Plant_system.

4.2.276.3 service_description

The service_description specifies a textual or summary label for the system.

EXAMPLE Examples of service_description labels include Boiler Feedwater System, Paraxylene System, Pipe Rack K, and 4160V Power System.

4.2.276.4 approval_state

The approval_state indicates the current status of the system.

4.2.277. Plant_system_assembly

A Plant_system_assembly is a collection of Plant_system (see **4.2.276**) objects into a higher-level system to perform a functional capability.

The data associated with a Plant_system_assembly are the following:

- subsystem;
- supersystem.

4.2.277.1 subsystem

The subsystem specifies the plant_id and plant_system_id of the Plant_system (see **4.2.276**) that is the component system in the Plant_system_assembly.

4.2.277.2 supersystem

The supersystem specifies the plant_id and plant_system_id of the Plant_system (see **4.2.276**) that is the assembly system in the Plant_system_assembly.

4.2.278. Plant_volume

A Plant_volume is a type of Plant_item_instance (see **4.2.269**) that is a specifically defined volume located within a Plant (see **4.2.258**) that may, but need not be occupied by physical Plant_item (see **4.2.260**) objects. Each Plant_volume may be one of the following: a Reserved_space (see **4.2.300**), a Route (see **4.2.302**), or a System_space (see **4.2.350**).

The data associated with a Plant_volume are the following:

- type.

The type specifies a designation that classifies the Plant_volume.

EXAMPLE Examples of Plant_volume object type classifications include reserved space, zone-area, area classification zone, equipment pull space, and egress for personnel.

4.2.279. Plate

A Plate is a type of Pipe_closure (see **4.2.237**) that consists of a flat piece that is welded on the end of the Pipe (see **4.2.236**).

NOTE Figure 50 depicts a typical Plate.

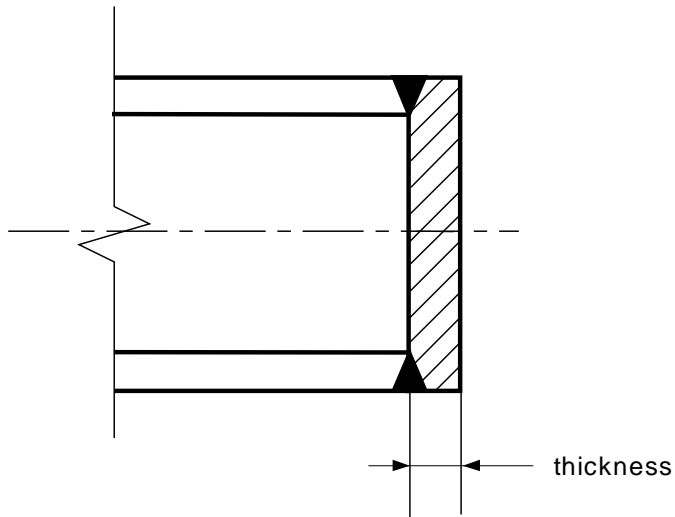


Figure 50 - Plate

The data associated with a Plate are the following:

— thickness.

The thickness is the distance between the parallel faces of the Plate.

4.2.280. Plug

A Plug is a type of Pipe_closure (see 4.2.237) that closes off the end of a Pipe (see 4.2.236) by fitting within the inside wall of the Pipe.

NOTE Figure 51 depicts a typical Plug.

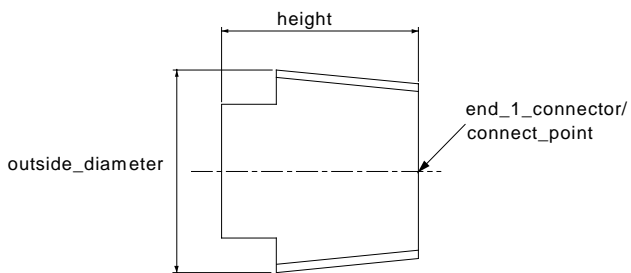


Figure 51 - Plug

The data associated with a Plug are the following:

— height.

The height specifies the axial length of Plug.

4.2.281. Point

A Point is a type of Wire_and_surface_element (see 4.2.372) that is a dimensionless location in space.

4.2.282. Point_and_line_representation

A Point_and_line_representation is a type of Site_shape_representation (see 4.2.315) represented as a collection of Point (see 4.2.281) objects that define the surface grid of the topography of a Site (see 4.2.313).

4.2.283. Polygon

A Polygon is a type of Curve (see 4.2.85) that is composed of a set of points connected by line segments that form a planar, closed, non-self-intersecting figure.

4.2.284. Pressure_class

A Pressure_class is a type of Piping_size_description (see 4.2.244) based on pressure rating or classification and a nominal size value.

NOTE This type of Piping_size_description (see 4.2.244) is commonly associated with a dimensional specification, such as the ANSI B16.5 specification for Flange objects.

The data associated with a Pressure_class are the following:

- nominal_size;
- pressure_rating.

4.2.284.1 nominal_size

The nominal_size specifies a standard size designation of the Piping_system_component (see 4.2.250) or Piping_connector (see 4.2.242). It may be specified as a single value or as a range of values.

NOTE 1 The nominal size need not represent an actual dimension.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.284.2 pressure_rating

The pressure_rating specifies a nominal pressure for the design of the Piping_system_component (see 4.2.250) or Piping_connector (see 4.2.242). It may be specified as a single value or as a range of values.

NOTE 1 When specified with a dimensional standard, such as ANSI B16.1, its value corresponds to a selection out of a set of available values (e.g., 150 PSI, 300 PSI).

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.285. Pressure_fit

A `Pressure_fit` is a type of `Piping_connector` (see 4.2.242) that is a physical feature of a `Plant_item` (see 4.2.260) that intended to establish a connection with another connector through pressure between the connector rather than by means of threading, welds, or fasteners.

4.2.286. `Process_ducting`

A `Process_ducting` is a type of `Ducting_component` (see 4.2.90) and `Piping_system_component` (see 4.2.250) that consists of `Piping_component` (see 4.2.240) objects or ductwork that is used to convey process streams in a `Plant` (see 4.2.258).

NOTE `Process_ducting` is used for venting gaseous portions of the process stream. It is part of the system that handles the process stream, but is ductwork rather than piping.

The data associated with a `Process_ducting` are the following:

— `gauge`.

The `gauge` specifies a designation that refers to the thickness of the `Process_ducting`.

4.2.287. `Project_design_assignment`

A `Project_design_assignment` is an assignment of a `Plant_item` (see 4.2.260) to a `Design_project` (see 4.2.87).

NOTE The set of `Project_design_assignment` instances for a project defines the items and areas that are part of the project.

4.2.288. `Pyramid`

A `Pyramid` is a type of `Csg_element` (see 4.2.84) that is a 3D volume with a rectangular base and four triangular sides that meet at an apex. The axis of a `Pyramid` is the line segment from the centre of the base to the apex.

4.2.289. `Raceway`

A `Raceway` is a type of `Cableway_piece` (see 4.2.22) that has a rectangular cross section and contains one or more channels for holding cables.

EXAMPLE Surface raceway, ladder-type raceway.

4.2.290. `Raceway_lane`

A `Raceway_lane` is a type of `Cableway_component` (see 4.2.19) that is a channel within a `Raceway` (see 4.2.289) for holding cables.

4.2.291. `Raceway_size_description`

A `Raceway_size_description` is a type of `Cableway_size_description` (see **4.2.23**) that is used to explain or summarize the physical size of a Raceway (see **4.2.289**) based on a set of dimensional characteristics.

The data associated with a `Raceway_size_description` are the following:

- `outer_width`;
- `outer_height`;
- `inner_width`;
- `inner_height`.

4.2.291.1 `outer_width`

The `outer_width` is the horizontal measurement of the outer surface of a Raceway (see **4.2.289**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.291.2 `outer_height`

The `outer_height` is the vertical measurement of the outer surface of a Raceway (see **4.2.289**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.291.3 `inner_width`

The `inner_width` is the horizontal measurement of the inner surface of a Raceway (see **4.2.289**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.291.4 `inner_height`

The `inner_height` is the vertical measurement of the inner surface of a Raceway (see **4.2.289**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.292. Reducer

A Reducer is a type of Fitting (see **4.2.118**) that provides a reduction from one Pipe (see **4.2.236**) size to another. Each Reducer may be an `Eccentric_reducer` (see **4.2.97**).

NOTE Figure 52 depicts a typical butt-weld Reducer.

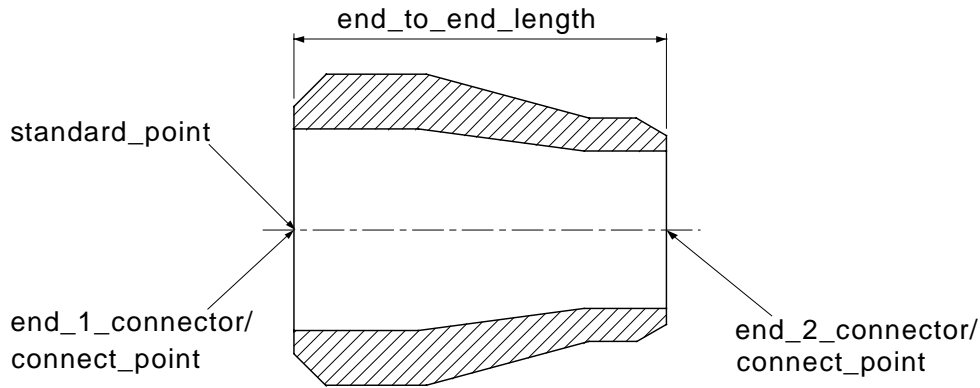


Figure 52 - Reducer

The data associated with a Reducer are the following:

- end_1_connector;
- end_2_connector;
- end_to_end_length.

4.2.292.1 end_1_connector

The end_1_connector specifies the Piping_connector (see **4.2.242**) that connects to the larger size Pipe (see **4.2.236**).

4.2.292.2 end_2_connector

The end_2_connector specifies the Piping_connector (see **4.2.242**) that connects to the smaller size Pipe (see **4.2.236**).

4.2.292.3 end_to_end_length

The end_to_end_length specifies the external distance between the end-one face and the end-two face of the Reducer. It may be specified as a single value or as a range of values.

NOTE 1 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

NOTE 2 Swage is a synonym for Reducer which is normally used for smaller sizes.

4.2.293. Reducing_flange

A Reducing_flange is a type of Flange (see **4.2.119**) used to make a Flanged (see **4.2.120**) joint between Pipe (see **4.2.236**) objects of different nominal sizes that has the dimensional characteristics of the larger Pipe and the bore of the smaller Pipe.

EXAMPLE Examples of Reducing_flange types include Weld_neck_flange (see 4.2.370), Slip_on_flange (see 4.2.317), Socket_weld_flange (see 4.2.320), and Threaded_flange (see 4.2.353).

NOTE Figure 53 depicts a typical Reducing_flange.

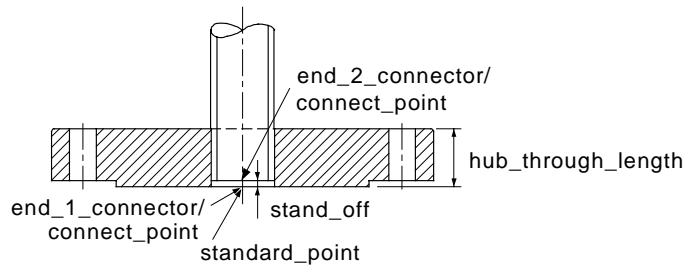


Figure 53 - Reducing_flange

The data associated with a Reducing_flange are the following:

— stand_off.

The stand_off specifies the measure of the distance between the face of the Reducing_flange and the end of the Pipe (see 4.2.236) that is inserted into the Reducing_flange. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.294. Reducing_torus

A Reducing_torus is a type of Csg_element (see 4.2.84) that is formed by sweeping a circle that uniformly decreases in size through a circular sweep angle of less than 360 degrees.

4.2.295. Reference_geometry

A Reference_geometry is the identification of one or more Shape_representation_element (see 4.2.310) objects in a model that are not part of a component shape, but provide additional geometric information relative to the shape of the Plant_item (see 4.2.260). Each Reference_geometry may be a Plant_item_centreline (see 4.2.261).

The data associated with a Reference_geometry are the following:

— name.

The name specifies a textual label given to the Reference_geometry.

4.2.296. Reinforcing_component

ISO/CD 10303-227

A Reinforcing_component is a type of Piping_component (see 4.2.240) which is used to strengthen the Piping_spool (see 4.2.246).

The data associated with a Reinforcing_component are the following:

- end_1_connector;
- location_point;
- orientation.

4.2.296.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.242) on the Reinforcing_component to the pipe.

4.2.296.2 location_point

The location_point is a standard point on Piping_component (see 4.2.240) at which the Reinforcing_component is attached.

4.2.296.3 orientation

The orientation specifies a unit vector in the direction perpendicular to the centreline of the run pipe. The vector defines the layout of the Reinforcing_component.

4.2.296.4 reinforcing component types

Necessary information for piping shop fabrication: type, location point, orientation and dimensional parameters. Types of Reinforcing_components include: Gusset (see 4.2.138), Reinforcing_plate (see 4.2.297), and Stay (see 4.2.330).

4.2.297. Reinforcing_plate

A Reinforcing_plate is a type of Reinforcing_component (see 4.2.296) that is made of plate that has a hole at its centre. It is firmly attached to run pipe and branch pipe to prevent the welded part between the branch pipe and the run pipe from breaking.

NOTE Figure 54 depicts a typical Reinforcing_plate.

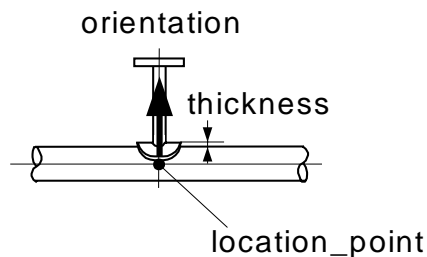


Figure 54 - Reinforcing_plate

The data associated with a Reinforcing_plate are the following:

— thickness.

The thickness is the distance of the top face of the Reinforcing_plate from the surface of the run pipe.

4.2.298. Relative_item_location

A Relative_item_location is a type of Plant_item_location (see **4.2.272**) that is the relative position of the Plant_item (see **4.2.260**) with respect to another Plant_item.

4.2.299. Required_material_description

A Required_material_description is a specification of the substances or the requirements of the substances that a component is to be made from.

The data associated with a Required_material_description are the following:

— description;

— material_requirement_id.

4.2.299.1 description

The description specifies a textual explanation or summary of the required materials.

4.2.299.2 material_requirement_id

The material_requirement_id specifies a unique identifier for the specification that provides the required material. Material_requirement_id is required for each Required_material_description.

NOTE The identifier is normally a coded value that is company-specific.

4.2.300. Reserved_space

A Reserved_space is a type of Plant_volume (see **4.2.278**) that is a region of space that is not to be obstructed by physical objects for reasons related to plant operation.

NOTE Reserved_spaces are normally prescriptive.

EXAMPLE Reserved_spaces include maintenance volume, operator access, and safety zone.

4.2.301. Ring_spacer

A Ring_spacer is a type of Spacer (see **4.2.322**) that fits between Flange (see **4.2.119**) objects in a Flanged (see **4.2.120**) joint to bridge a large gap or fill a slight angle between the Flange objects that cannot be accommodated by standard Flange gaskets.

NOTE Figure 55 depicts a typical Ring_spacer.

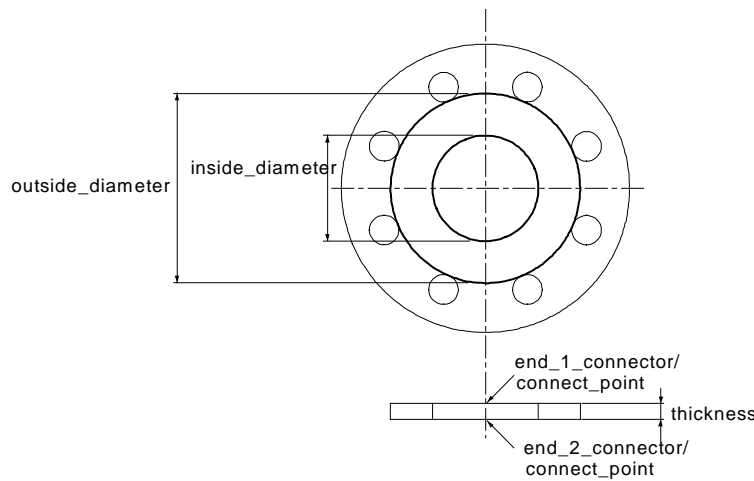


Figure 55 - Ring_spacer

The data associated with a Ring_spacer are the following:

— inside_diameter.

The inside_diameter specifies the diameter of the bore hole through the Ring_spacer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.302. Route

A Route is a type of Plant_volume (see 4.2.278) that is a 3D path from one location to another.

NOTE 1 A Route is a conceptual engineered path that reserves space for a Piping_system (see 4.2.249). This space need not be occupied by a Plant_item (see 4.2.260) at a future time.

NOTE 2 The shape of the reserved volume of a Route is a specified Plant_item_shape (see 4.2.273).

EXAMPLE A cable trench is a kind of Route that goes through and runs underneath the surface of a Site (see 4.2.313).

4.2.303. Schedule

A Schedule is a type of Piping_size_description (see 4.2.244) that gives the Pipe (see 4.2.236) or Piping_component (see 4.2.240) size in terms of nominal size and a sizing schedule.

NOTE When a Schedule entity is used, the dimensional standard attribute of Piping_size_description (see 4.2.244) must be specified.

The data associated with a Schedule are the following:

— nominal_size;

— pipe_schedule.

4.2.303.1 nominal_size

The `nominal_size` specifies a standard size designation of the `Piping_system_component` (see **4.2.250**) or `Piping_connector` (see **4.2.242**). It may be specified as a single value or as a range of values.

NOTE 1 The nominal size need not represent an actual dimension.

NOTE 2 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.303.2 pipe_schedule

The `pipe_schedule` specifies a designation of a standard wall thickness and external diameter for a nominal pipe size through a reference to the dimensional standard.

4.2.304. Segment_insulation

A `Segment_insulation` is a logical connection between a `Piping_system_line_segment` (see **4.2.252**) and the `Insulation` (see **4.2.191**) attached to the `Pipe` (see **4.2.236**) associated with the `Piping_system_line_segment`.

The data associated with a `Segment_insulation` are the following:

- boundaries;
- description;
- line_number;
- thickness;
- type.

4.2.304.1 boundaries

The `boundaries` specifies a description that defines the boundaries for `Insulation` (see **4.2.191**) on the `Piping_system_line` (see **4.2.251**).

EXAMPLE An example description for the `Insulation` (see **4.2.191**) boundaries of a `Piping_system_line` (see **4.2.251**) is personnel protection insulation shall extend to 12 feet above grade or walkway.

4.2.304.2 description

The `description` specifies a textual explanation or summary of the reasons for providing `Insulation` (see **4.2.191**).

EXAMPLE Examples of `Piping_system_line` (see **4.2.251**) `Insulation` (see **4.2.191**) descriptions include provided for heat conservation and provided for personnel protection.

4.2.304.3 line_number

The `line_number` specifies an alphanumeric identifier assigned to the `Piping_system_line` (see **4.2.251**) and can be used to uniquely define the `Piping_system_line`. `Line_number` is required for each `Piping_system_line`.

The thickness specifies the distance between the inside and outside surfaces of the Insulation (see **4.2.191**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values. The thickness of the insulation may vary over the extent of the insulation.

4.2.304.5 type

The type specifies the Insulation (see **4.2.191**) material.

4.2.305. Service_operating_case

A Service_operating_case is a stream condition that may exist at a Plant_item_connector (see **4.2.265**).

EXAMPLE Examples of Service_operating_case conditions include normal, upset, and shutdown.

The data associated with a Service_operating_case are the following:

- duration;
- frequency;
- name;
- operating_pressure;
- operating_temperature.

4.2.305.1 duration

The duration specifies the expected time span of the Service_operating_case. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.305.2 frequency

The frequency specifies the expected number of times that the Service_operating_case will occur over a defined period of time. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.305.3 name

The name specifies a textual label given to the condition that the Equipment (see **4.2.104**) operating characteristics are being defined under.

4.2.305.4 operating_pressure

The `operating_pressure` specifies the force per unit area exerted by the process stream on the `Plant_item` (see **4.2.260**) under a specific `Service_operating_case`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.305.5 `operating_temperature`

The `operating_temperature` specifies the temperature of the process stream on the `Plant_item` (see **4.2.260**) under a specific `Service_operating_case`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.306. `Shape_inspection_record`

A `Shape_inspection_record` is a collection of information that captures the result of an evaluation of an observed value for a characteristic of the shape of a `Piping_spool` (see **4.2.246**) against an expected, designed or prescribed value for that characteristic, as well as information to evaluate the acceptability of the observed value.

The data associated with a `Shape_inspection_record` are the following:

- `shape_inspection_property_name`;
- `shape_inspection_property_sequence_number`;
- `inspected_property_tolerance`;
- `inspected_property_measured_value`.

4.2.306.1 `shape_inspection_property_name`

The `shape_inspection_property_name` specifies the characteristic for which information is being recorded. The `shape_inspection_property_name` may be one of the following:

- point to point length;
- point to point angle;
- planarity;
- attached element location;
- attached element orientation.

4.2.306.2 `shape_inspection_property_sequence_number`

The `shape_inspection_property_sequence_number` specifies an alphanumeric string that identifies the node point that defines the shape property that is being measured. There may be more than one `shape_inspection_property_sequence_number` for a `Shape_inspection_record`.

NOTE The method of identification is outside the scope of this part of ISO 10303.

4.2.306.3 `inspected_property_tolerance`

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The `inspected_property_tolerance` specifies the acceptable deviation for the measured result of the inspection.

4.2.306.4 `inspected_property_measured_value`

The `inspected_property_measured_value` specifies the recorded result of the inspection.

4.2.307. Shape_interference_zone_usage

A `Shape_interference_zone_usage` is the representational elements that define the shape of a volume that encloses the region of space where the interference of clashing `Plant_items` (see **4.2.260**) occurs.

The data associated with a `Shape_interference_zone_usage` are the following

- `first_item`;
- `second_item`.

4.2.307.1 `first_item`

The `first_item` specifies the `plant_item_id` of one of the `Plant_items` (see **4.2.260**) that is interfering.

4.2.307.2 `second_item`

The `second_item` specifies the `plant_item_id` of one of the `Plant_items` (see **4.2.260**) that is interfering.

4.2.308. Shape_parameter

A `Shape_parameter` is a type of `Shape_representation_element` (see **4.2.310**) that is a name-value pair that specifies the dimensional value of some aspect of the `Plant_item_shape` (see **4.2.273**). The meaning of the name-value pair is not specified in this part of ISO 10303.

NOTE 1 A use of this structure is to provide a generic capability to reference classes of `Plant_items` (see **4.2.260**) by a dimensional characteristic, such as 5 centimeter pipe.

NOTE 2 It was not the intent of this object to use this structure to create a geometric representation of an item. The effective use of this structure requires an agreement between the exchanging parties as to the meanings of the names so that they can understand the information being exchanged.

The data associated with a `Shape_parameter` are the following:

- `name`;
- `value`.

4.2.308.1 `name`

The name specifies a textual label given to a dimension or parameter of a Plant_item_shape (see 4.2.273).

EXAMPLE An example of this is the name "diameter".

4.2.308.2 value

The value specifies a number that represents the measure of the dimension or parameter of the Plant_item_shape (see 4.2.273).

EXAMPLE An example of this is the value "5.6".

4.2.309. Shape_representation

A Shape_representation is a combination of geometric elements that describe or define the general or specific surface boundaries of a Plant_item (see 4.2.260). Shape_representation is either a Hybrid_shape_representation (see 4.2.181) or Plant_csg_shape_representation (see 4.2.259).

NOTE Shape representation need not be the exact or specific shape of the item.

4.2.310. Shape_representation_element

A Shape_representation_element is a geometric model that is used to represent the shape or some aspect of the shape of a Plant_item (see 4.2.260). Each Shape_representation_element is either a B_rep_element (see 4.2.2), a Csg_element (see 4.2.84), a Shape_parameter (see 4.2.308), or a Wire_and_surface_element (see 4.2.372).

4.2.311. Shape_representation_element_usage

A Shape_representation_element_usage is an assignment of a Shape_representation_element (see 4.2.310) to a Shape_representation (see 4.2.309) of a Plant_item (see 4.2.260).

NOTE Shape_representation_element_usage is the mechanism that aggregates the geometric elements that represent the shape of the Plant_item (see 4.2.260). The rules are constraints for what constitutes a valid aggregation are delineated by conformance class.

The data associated with a Shape_representation_element_usage are the following:

— element_colour;

— layer.

4.2.311.1 element_colour

The element_colour specifies the colour that displays the element.

4.2.311.2 layer

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The layer specifies the collection of displayable items for the purpose of controlling visibility and presentation style.

4.2.312. Shoe

A Shoe is a type of Piping_support (see 4.2.248) that is composed of Plates (see 4.2.279), and which has a cross-sectional shape that resembles a reversed “T” or reversed PI. The Shoe supports the weight rigidly at its base, and is used to regulate the movement or to fix the position of pipe.

NOTE Figure 56 depicts a typical Shoe.

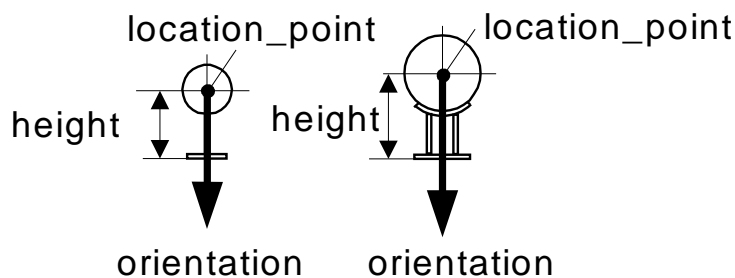


Figure 56 - Shoe

The data associated with a Shoe are the following:

— height.

The height is the distance between the supporting face of the base plate of the Shoe and location_point.

4.2.313. Site

A Site is a geographical location where the Plant (see 4.2.258) is located. The z-axis of the local coordinate system of the Site shall be considered the elevation of the coordinate space.

The data associated with a Site are the following:

— address;

— coordinates;

— elevation;

— environmental_references;

— locality;

- name;
- orientation;
- owners;
- site_id.

4.2.313.1 address

The address specifies the street address (including city, state, and zip code as appropriate) of the Site.

4.2.313.2 coordinates

The coordinates specifies the longitude and latitude coordinates of the Site with respect to a known Point (see **4.2.281**) on the Site.

4.2.313.3 elevation

The elevation specifies the distance that the Site is located above sea level with respect to a known Point (see **4.2.281**) on the Site.

NOTE The Point (see **4.2.281**) referenced here is the same point referenced under coordinates.

4.2.313.4 environmental_references

The environmental_references specifies a reference to a Document (see **4.2.89**) that provides environmental information relevant to the Site.

EXAMPLE Environmental_references specify Documents (see **4.2.89**) that describe the conditions of the environment that a Plant (see **4.2.258**) operates in that affect the design, such as snow loads, wind loads, and seismic data.

4.2.313.5 locality

The locality specifies the municipality or region where the Site is located.

4.2.313.6 name

The name specifies a textual label given to the Site.

4.2.313.7 orientation

The orientation specifies the relative alignment of the Site with respect to a given compass direction.

4.2.313.8 owners

The owners specify the company or organization that is financially responsible the Site.

4.2.313.9 site_id

The site_id specifies a unique identifier for the Site. Site_id is required for each Site.

4.2.314. Site_feature

A Site_feature is the composition, proportions, form, or outward appearance of some thing of interest on a Site (see **4.2.313**).

EXAMPLE A Site_feature may be man-made, such as a building, road, railway, water tower or they may be natural, such as a river, hill, or forest.

The data associated with a Site_feature are the following:

- location_and_orientation;
- man_made_or_natural;
- shape;
- site_feature_id;
- type.

4.2.314.1 location_and_orientation

The location_and_orientation specifies the position of the Site_feature relative to the Site (see **4.2.313**) coordinate system and the orientation of the Site_feature relative to a specified direction.

4.2.314.2 man_made_or_natural

The man_made_or_natural specifies that the Site_feature is either man-made or natural, and provides a short descriptive name or title of the feature.

4.2.314.3 shape

The shape specifies a 3D spatial volume that completely encloses or bounds a feature.

NOTE The shape of the Site_feature is necessary for the spatial layout of buildings and the piping between buildings.

4.2.314.4 site_feature_id

The site_feature_id specifies a unique identifier for the Site_feature.

4.2.314.5 type

The type specifies a designation that classifies a Site_feature based on its physical and functional characteristics.

4.2.315. Site_shape_representation

A Site_shape_representation is a replica of the topography of a specific area. Each Site_shape_representation is either a Faceted_surface_representation (see **4.2.114**) or a Point_and_line_representation (see **4.2.282**).

4.2.316. Sited_plant

A Sited_plant is a Planned_physical_plant (see 4.2.256) that a Site (see 4.2.313) location has been defined for.

The data associated with a Sited_plant are the following:

- plant_site_location;
- plant_site_orientation.

4.2.316.1 plant_site_location

The plant_site_location specifies the geographic position of the Plant (see 4.2.258) relative to the Site (see 4.2.313) or a feature of the Site.

4.2.316.2 plant_site_orientation

The plant_site_orientation specifies the directional orientation of the Plant (see 4.2.258) with respect to the Site (see 4.2.313).

4.2.317. Slip_on_flange

A Slip_on_flange is a type of Flange (see 4.2.119) that slips over the end of a Pipe (see 4.2.236) or Fitting (see 4.2.118) and is fillet welded in place.

NOTE Figure 57 depicts a typical Slip_on_flange.

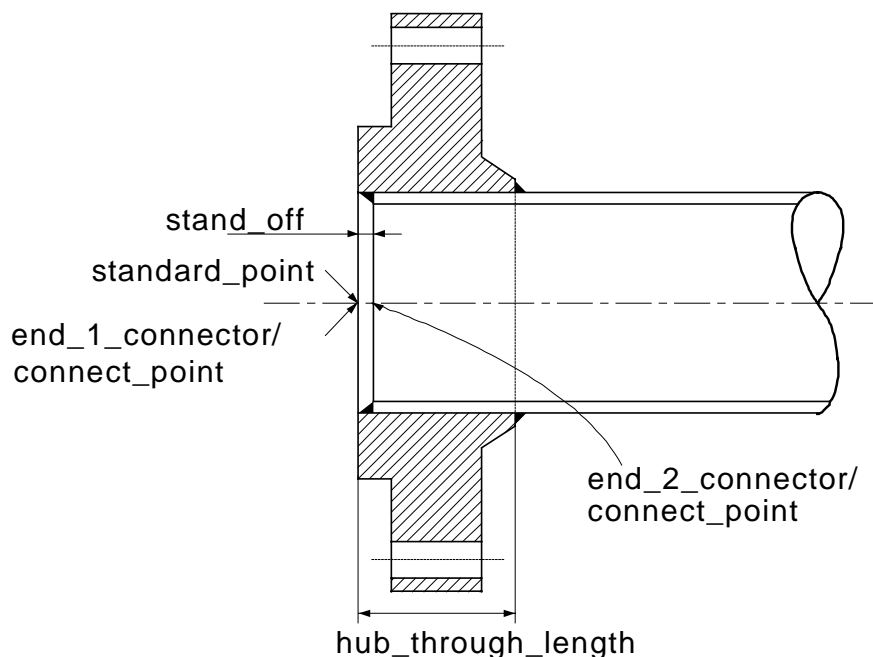


Figure 57 - Slip_on_flange

The data associated with a Slip_on_flange are the following:

— stand_off.

The stand_off specifies the measure of the distance between the face of the Slip_on_flange and the end of the Pipe (see 4.2.236) or the Fitting (see 4.2.118) that is inserted into the Slip_on_flange. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.318. Slip_on_jacket_flange

A Slip_on_jacket_flange is a type of Slip_on_flange (see 4.2.317) that slips over the end of a jacketed Piping_spool (see 4.2.246), and closes off the jacket.

NOTE Figure 58 depicts a typical Slip_on_jacket_flange.

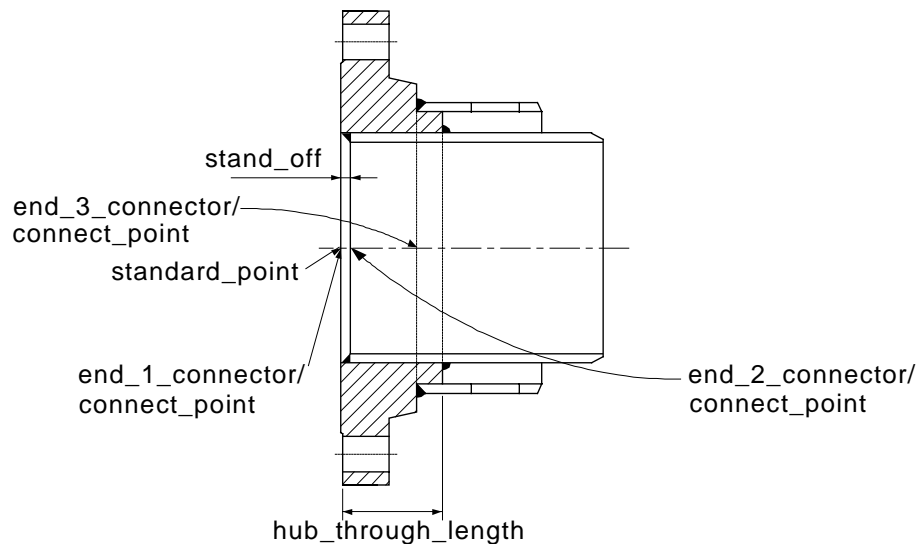


Figure 58 - Slip_on_jacket_flange

The data associated with a Slip_on_jacket_flange are the following:

— end_3_connector.

The end_3_connector specifies the Piping_connector (see 4.2.242) where the outside Pipe (see 4.2.236) of the jacketed piping connects to the Flange (see 4.2.119).

4.2.319. Socket

A Socket is a type of Piping_connector (see 4.2.242) that is a physical feature of a Plant_item (see 4.2.260) that allows partial insertion of the Male_end (see 4.2.215) of another Plant_item.

NOTE 1 The location of the connect point should be based on the dimension from the centreline to the bottom of the Socket of a Valve (see 4.2.367) or Fitting (see 4.2.118) plus the set_back.

NOTE 2 Figure 59 depicts a typical Socket.

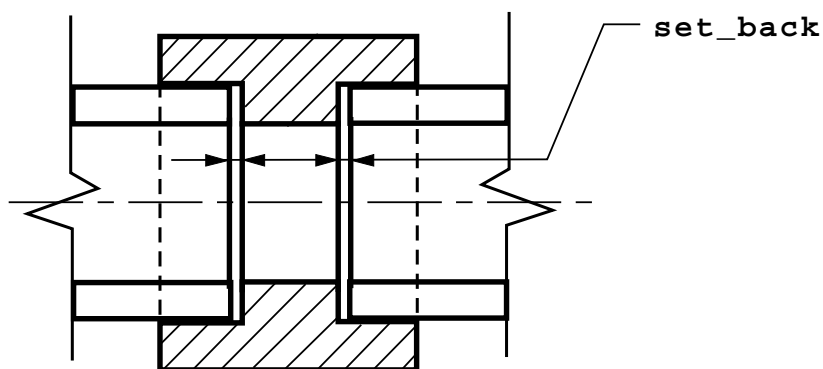


Figure 59 - Socket

The data associated with a Socket are the following:

— set_back.

The set_back specifies the distance between the end of the Piping_component (see 4.2.240) and the bottom of the Socket.

NOTE The attribute for set_back will only be used when the Piping_component (see 4.2.240) participates in a connection.

4.2.320. Socket_weld_flange

A Socket_weld_flange is a type of Flange (see 4.2.119) having a Socket (see 4.2.319) configuration that fits the end of a Pipe (see 4.2.236) for fillet welding.

NOTE Figure 60 depicts a typical Socket_weld_flange.

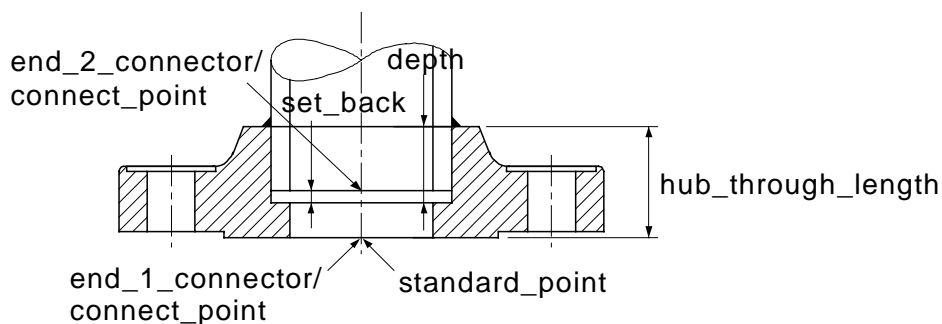


Figure 60 - Socket_weld_flange

4.2.321. Solid_of_revolution

A Solid_of_revolution is a type of Csg_element (see **4.2.84**) that is formed by sweeping a 2D shape about an axis. The 2D shape may be closed or open; if open, then the ends of the 2D shape must lie on the sweep axis.

4.2.322. Spacer

A Spacer is a type of Fitting (see **4.2.118**) that is placed between two Flange (see **4.2.119**) objects to enable the flow of material between the pipelines on either side of the Spacer. Each Spacer may be one of the following: a Paddle_spacer (see **4.2.231**), or a Ring_spacer (see **4.2.301**).

The data associated with a Spacer are the following:

- outside_diameter;
- thickness.

4.2.322.1 outside_diameter

The outside_diameter specifies the external diameter of the Spacer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.322.2 thickness

The thickness specifies the distance between the two parallel faces of the Spacer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.323. Spare_plant_item_usage

A Spare_plant_item_usage is an association between a primary Plant_item (see **4.2.260**) and a Plant_item used as a spare for the primary Plant_item.

4.2.324. Specialty_item

A Specialty_item is a type of Piping_system_component (see **4.2.250**) whose specific dimensional design or configuration is not met by some standard commodity item.

The data associated with a Specialty_item are the following:

- type.

The type specifies a category that the item is part of.

EXAMPLE Examples of Specialty_item types include Flange (see **4.2.119**) and Valve (see **4.2.367**).

4.2.325. Spectacle_blind

A Spectacle_blind is a type of Blank (see 4.2.5) that consists of two paddles connected by an arm. One paddle blocks the flow of material (see Paddle_blank in 4.2.230) and the other is a ring that permits or alters the flow (see Paddle_spacer in 4.2.231). A spectacle either allows or disallows flow in a pipe depending on which end of the spectacle is installed in line. It is often used to isolate a section of the Piping_system (see 4.2.249) or Equipment (see 4.2.104).

NOTE 1 The term spectacle refers to shape of the item, that resembles a pair of spectacles (i.e., reading glasses).

NOTE 2 Figure 61 depicts a typical Spectacle_blind.

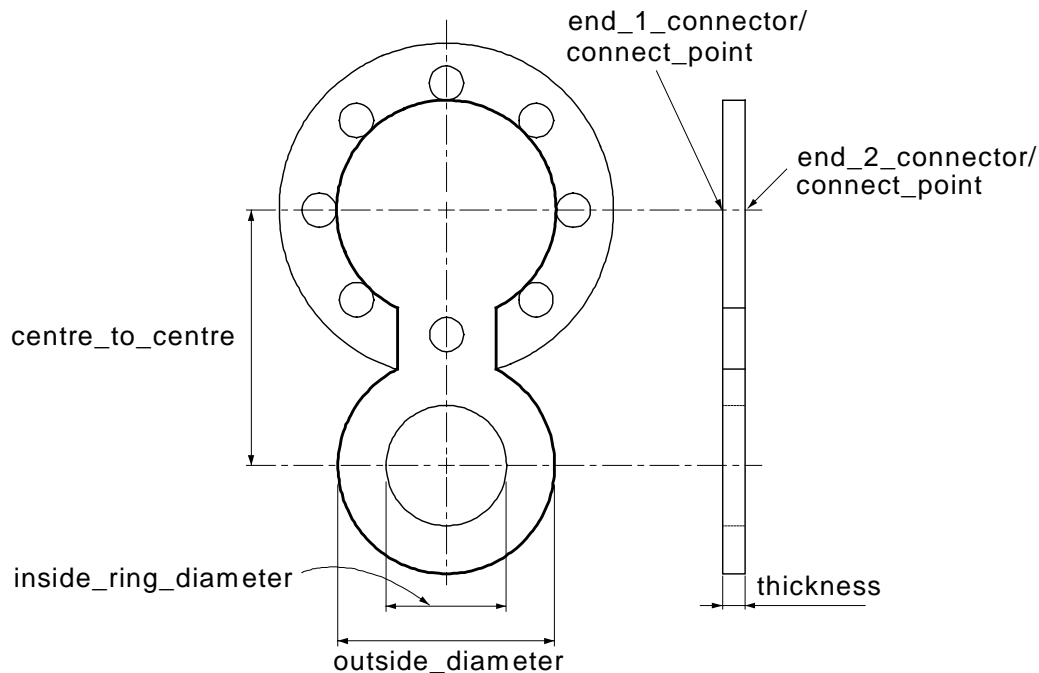


Figure 61 - Spectacle_blind

The data associated with a Spectacle_blind are the following:

- arm_width;
- centre_to_centre;
- inside_ring_diameter.

4.2.325.1 arm_width

The arm_width specifies the width of the arm connecting the paddles. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.325.2 centre_to_centre

The `centre_to_centre` specifies the distance between the geometric centres of the paddles. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.325.3 `inside_ring_diameter`

The `inside_ring_diameter` specifies the diameter of the bore hole through the ring paddle. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.326. Sphere

A Sphere is a type of `Csg_element` (see **4.2.84**) that is a solid bounded by a surface at a constant radius from a centre point.

4.2.327. Splitter

A Splitter is a vane which is placed inside an `Hvac_fitting` (see **4.2.157**) for the purpose of directing flow.

The data associated with a Splitter are the following:

- `splitter_id`;
- `splitter_radius`;
- `splitter_radius_centre_offset`;
- `straight_portion_length`.

4.2.327.1 `splitter_id`

This attribute specifies a unique identifier for the Splitter.

4.2.327.2 `splitter_radius`

This attribute specifies the radius of the Splitter.

4.2.327.3 `splitter_radius_centre_offset`

This attribute specifies the vertical distance from the throat centre to the Splitter centre.

4.2.327.4 `straight_portion_length`

This attribute specifies the length of the straight portion of the Splitter.

4.2.328. Spring_washer

A Spring_washer is a type of Washer (see **4.2.369**). The Spring_washer has one radial cut and both ends are pulled to opposite directions, and is furnished with the function of a coil spring.

The data associated with a Spring_washer are the following

- thickness;
- outside_diameter.

4.2.328.1 thickness

The thickness specifies the distance between two faces of the material plate of the Spring_washer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.328.2 outside_diameter

The outside_diameter specifies the external diameter of the Spring_washer. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.329. Square_to_round

A Square_to_round is a type of Csg_element (see 4.2.84) that consists of a planar, rectangular surface, a planar circular surface parallel to the rectangular surface, and an enclosing, transitional surface that connects the boundaries of the rectangular surface and circular surface.

4.2.330. Stay

A Stay is a type of Reinforcing_component (see 4.2.296) that is a tensile member placed between a run pipe and a branch pipe that are arranged in parallel. The Stay prevents the branch pipe from breaking or deforming.

NOTE Figure 62 depicts a typical Stay.

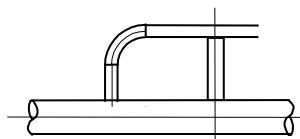


Figure 62 - Stay

The data associated with a Stay are the following:

- height.

The height is the distance between the location_point and the centreline of the branch pipe that is reinforced by the Stay.

4.2.331. Stopper

A Stopper is a type of Piping_support (see 4.2.248) that consists of a plate perpendicularly fixed to the pipe axis and one or more strengthening plates for the perpendicular plate. The Stopper is used to prevent the pipe from moving.

NOTE Figure 63 depicts a typical Stopper.

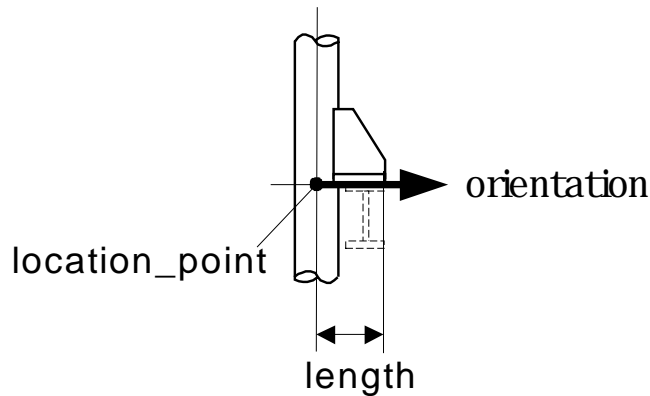


Figure 63 - Stopper

The data associated with a Stopper are the following:

— length.

The length is the distance between the outer face of the Stopper and the location_point.

4.2.332. Straight_pipe

A Straight_pipe is a type of Pipe (see 4.2.236) that does not change the direction of fluid flow.

The data associated with a Straight_pipe are the following:

— end_to_end_cut_length;

— end_to_end_length.

4.2.332.1 end_to_end_cut_length

The end_to_end_cut_length is the length of the Straight_pipe for shop fabrication that takes into account extra length required for installation variations and the subtracted length for the difference between designed length and shop fabricated length.

EXAMPLE The root_gap of the Buttweld (see 4.2.16) is an example of the difference between designed length and shop fabricated length.

4.2.332.2 end_to_end_length

The end_to_end_length specifies the external length of the Straight_pipe. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.333. Stream_design_case

A `Stream_design_case` is the set of characteristics of a gas, liquid, vapour, or solid stream under a specific circumstance at the termination of a `Piping_system_line_segment` (see **4.2.252**) or a `Plant_item_connector_occurrence` (see **4.2.266**).

The data associated with a `Stream_design_case` are the following:

- `description`;
- `flow_rate`;
- `pressure`;
- `stream_case_type`;
- `stream_data_reference`;
- `stream_design_id`.

4.2.333.1 description

The `description` specifies a textual explanation or summary of the `Stream_design_case`.

4.2.333.2 flow_rate

The `flow_rate` specifies the stream volume, mass, or molar units per unit time. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.333.3 pressure

The `pressure` specifies the amount of force applied by the stream over a unit area. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.333.4 stream_case_type

The `stream_case_type` specifies the condition that the stream characteristics are being defined under. `Stream_case_type` is required for each `Stream_design_case`.

EXAMPLE Examples of `stream_case_type` conditions include normal, upset, and shutdown.

4.2.333.5 stream_data_reference

The `stream_data_reference` specifies the sources that provide the basis for the stream data.

4.2.333.6 stream_design_id

The `stream_design_id` specifies a unique identifier for the `Stream_design_case`. `Stream_design_id` is required for each `Stream_design_case`.

4.2.334. Stream_phase

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A `Stream_phase` is the set of characteristics of a single gas, liquid, vapour, or solid stream that may be composed into a `Stream_design_case` (see **4.2.333**).

The data associated with a `Stream_phase` are the following:

- `constituent_mole_fraction`;
- `constituents`;
- `phase_density`;
- `phase_fraction`;
- `specific_gravity`;
- `surface_tension`;
- `temperature`;
- `viscosity`.

4.2.334.1 constituent_mole_fraction

The `constituent_mole_fraction` specifies the mass ratio of any given component to the whole for the `Stream_phase`.

4.2.334.2 constituents

The `constituents` specifies the various chemicals for the `Stream_phase`.

4.2.334.3 phase_density

The `phase_density` specifies the amount of mass per unit volume for the `Stream_phase`.

4.2.334.4 phase_fraction

The `phase_fraction` specifies the percentage of the mass of this `Stream_phase` in the `Stream_design_case` (see **4.2.333**).

4.2.334.5 specific_gravity

The `specific_gravity` specifies the ratio of the mass of a liquid to the mass of an equal volume of distilled water at 4 degrees Celsius.

4.2.334.6 surface_tension

The `surface_tension` specifies the force per unit area of the cohesive forces at or near the surface of a liquid `Stream_phase`.

4.2.334.7 temperature

The temperature specifies the measure of molecular motion of a stream. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.334.8 viscosity

The viscosity specifies a measure of the resistance of a stream to deformation when subjected to a shear stress.

4.2.335. Structural_component

A Structural_component is a type of Plant_item (see **4.2.260**) that is an individually identifiable item or combination of items that is part of the Structural_system (see **4.2.337**).

NOTE Structural_component objects include structural steel members, load resisting walls, stairs, platforms foundations, supports (excluding pipe supports) for Plant_item (see **4.2.260**) objects, and have a primary function to transfer or resist live or dead loads.

The data associated with a Structural_component are the following:

- exact_section;
- size_designator;
- type.

4.2.335.1 exact_section

The exact_section specifies the detailed shape of a cross section of the structural element.

4.2.335.2 size_designator

The size_designator specifies the designation given to some types of plant structural elements to define cross-sectional size and general shape based on industry-standard practice.

EXAMPLE W30 X 132 is the U.S. American Institute of Steel Construction (AISC) designation for a wide flange beam of nominal 76.20 centimetres (30 inches) depth weighing 194.88 kilograms per metre (132 pounds per foot) of length. Similar designations exist for other plant structural elements such as angles, channels, and structural tee shapes. Also, like designations exist for other structural elements, e.g., reinforcing bar (#8 rebar).

4.2.335.3 type

The type specifies a designation that classifies a structural element based on its function in the Structural_system (see **4.2.337**).

EXAMPLE Examples of structural element types include beam, column, brace, support, grade beam, and pile.

4.2.336. Structural_load_connector

A Structural_load_connector is a type of Plant_item_connector (see **4.2.265**) that connects two Structural_component (see **4.2.335**) objects for the purpose of load transfer.

The data associated with a Structural_load_connector are the following:

— type.

The type specifies either a shear, moment, or shear and moment type of load at the connector.

4.2.337. Structural_system

A Structural_system is a type of Plant_system (see 4.2.276) that is an assembly of one or more Structural_component (see 4.2.335) objects and Structural_load_connector (see 4.2.336) objects.

The data associated with a Structural_system are the following:

— type.

The type specifies a designation that classifies the Structural_system based on the kind of service that it provides.

4.2.338. Stub_in

A Stub_in is a type of Piping_connector (see 4.2.242) that consists of the welding of two Piping_components (see 4.2.240) where a Male_end (see 4.2.215) of one Piping_component is inserted in a Branch_hole (see 4.2.12) of the other Piping_component.

NOTE Figure 64 depicts a typical Stub_in.

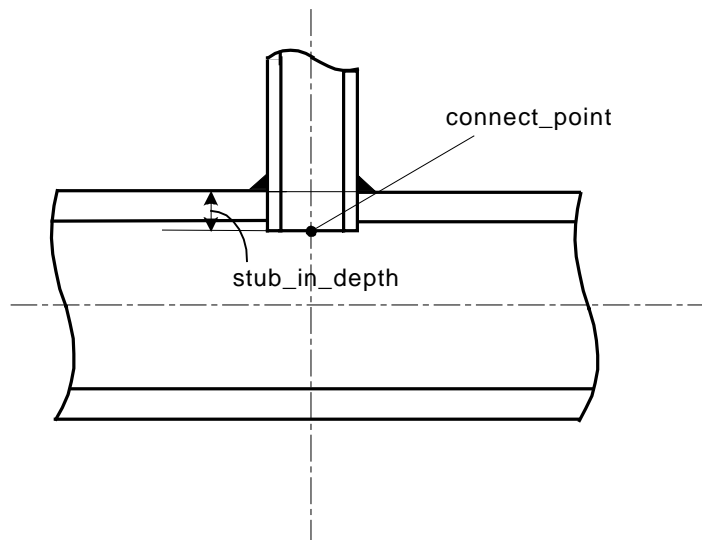


Figure 64 - Stub_in

The data associated with a Stub_in are the following

— stub_in_depth.

The stub_in_depth specifies the distance from the end of the stubbed-in Piping_component (see 4.2.240) to the Point (see 4.2.281) where the centre line of the stubbed-in Piping_component intersects the outer surface of the other Piping_component. It may be specified as a single value or as a range of values.

NOTE 1 See annex L for a discussion of attributes that may be assigned a single value or a range of values.

NOTE 2 The attribute for `stub_in_depth` will only be used when the `Piping_component` (see 4.2.240) participates in a connection.

4.2.339. Stud_bolt

A `Stud_bolt` is a type of a `Bolt` (see 4.2.8) that has screw threads on both ends.

The data associated with a `Stud_bolt` are the following

— `length`.

The `length` specifies the distance from the tip of one screw thread to the tip of the other screw thread of the `Stud_bolt`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.340. Sub_plant_relationship

A `Sub_plant_relationship` is the relationship between `Plant` (see 4.2.258) objects and sub-plants and defines their relative locations.

EXAMPLE Examples of `Sub_plant_relationships` include manufacturing Line (see 4.2.196), Train (see 4.2.356), and `Plant` (see 4.2.258) unit.

The data associated with a `Sub_plant_relationship` are the following:

— `component`;

— `contains`;

— `location_and_orientation`.

4.2.340.1 component

The `component` specifies the `plant_id` of the child `Plant` (see 4.2.258) in the `Sub_plant_relationship`.

4.2.340.2 contains

The `contains` specifies the `plant_id` of the parent `Plant` (see 4.2.258) in the `Sub_plant_relationship`.

4.2.340.3 location_and_orientation

The `location_and_orientation` specifies the relative position and orientation of the sub-plant within the `Plant` (see 4.2.258).

4.2.341. Supplied_equipment

ISO/CD 10303-227

A Supplied_equipment is an Equipment (see **4.2.104**) that is, or is to be, provided by a Supplier (see **4.2.342**) for use in a Plant (see **4.2.258**).

The data associated with a Supplied_equipment are the following:

- delivery_date;
- purchase_order_number;
- requisition_number.

4.2.341.1 delivery_date

The delivery_date specifies the calendar day-month-year and time when the Equipment (see **4.2.104**) was, or is, scheduled to be delivered to the Site (see **4.2.313**).

NOTE A specific ordering of the day, month, and year within the date is not required.

4.2.341.2 purchase_order_number

The purchase_order_number specifies an identifier assigned to the Equipment (see **4.2.104**) purchase order.

4.2.341.3 requisition_number

The requisition_number specifies an identifier assigned to a written request for a piece of Equipment (see **4.2.104**).

4.2.342. Supplier

A Supplier is the organization that produces a piece of Equipment (see **4.2.104**) or publishes a catalogue.

The data associated with a Supplier are the following:

- supplier_id;
- vendor_name.

4.2.342.1 supplier_id

The supplier_id specifies a unique identifier for the Supplier. Supplier_id is required for each Supplier.

4.2.342.2 vendor_name

The vendor_name specifies a textual label used by the company or organization that is providing the Equipment (see **4.2.104**).

4.2.343. Support_component

A **Support_component** is a type of **Plant_item** (see **4.2.260**) that is designed to support other **Plant_item** objects. This support includes carrying the weight of the **Plant_item**, including internal fluids and external insulation, permitting thermal expansion and contraction, and dampening any vibrational or seismic forces applied to the **Plant_item**. Each **Support_component** may be a **Cable_support** (see **4.2.18**).

EXAMPLE If a **Support_component** is not a **Cable_support** (see **4.2.18**), it may be a branch reinforcing pad, a hanger, a footer, pipe rack, or anything that supports the weight of a **Plant_item** (see **4.2.260**).

4.2.344. Support_constraints

A **Support_constraints** is a limitation on the movement of a **Plant_item** (see **4.2.260**) support, normally in specified directions.

The data associated with a **Support_constraints** are the following:

- gap;
- K;
- restrained.

4.2.344.1 gap

The gap specifies the allowable space between a **Plant_item** (see **4.2.260**) and a **Plant_item** support.

4.2.344.2 K

The K specifies the ratio between the force applied to the support and the support deflection produced by that force.

4.2.344.3 restrained

The restrained specifies a boolean indicator that specifies whether the **Plant_item** (see **4.2.260**) support limits movement of the **Plant_item** in a specified direction.

4.2.345. Support_usage

A **Support_usage** is the relationship between a defined load bearing element and the **Plant_item** (see **4.2.260**) that it provides support for. Each **Support_usage** may be a **Support_usage_connection** (see **4.2.346**).

The data associated with a **Support_usage** are the following:

- detail_sheet_reference;
- function.

4.2.345.1 detail_sheet_reference

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The `detail_sheet_reference` specifies the support detail drawings that define the support.

4.2.345.2 function

The function specifies the role or purpose of using the `Plant_item` (see **4.2.260**) as a support.

EXAMPLE Examples of function designations include anchor, guide, restraint, and support.

4.2.346. Support_usage_connection

A `Support_usage_connection` is a type of `Support_usage` (see **4.2.345**) that specifies the actual `Plant_item_connection_occurrence` (see **4.2.264**) where the support occurs.

4.2.347. Surface

A `Surface` is a type of `Wire_and_surface_element` (see **4.2.372**) that is a set of connected points in 3D geometric space that is always locally 2D, but need not be a manifold.

NOTE `Surface` has many subtypes. Besides being a self-contained object, `Surface` is used in the definition of other geometric objects such as `Point` (see **4.2.281**) objects and `Curve` (see **4.2.85**) objects. It will not be instantiated as it has no attributes.

4.2.348. Survey_point

A `Survey_point` is a particular location (position and elevation) on a `Site` (see **4.2.313**) relative to a known geographic location.

NOTE `Survey_point` data are established by performing a survey. The collection of `Survey_point` data can be interpolated to generate a faceted or surface representation of the topography of the `Site` (see **4.2.313**).

4.2.349. Swept_bend_pipe

A `Swept_bend_pipe` is a type of `Pipe` (see **4.2.236**) that is bent to alter the direction of flow of its contents.

The data associated with a `Swept_bend_pipe` are the following:

- `wall_thinning_allowance`;
- `centreline_radius`;
- `sweep_angle`.

4.2.349.1 wall_thinning_allowance

The `wall_thinning_allowance` specifies the amount of pipe wall material that must be provided to compensate for reduction in wall thickness of the `Pipe` (see **4.2.236**) caused by bending.

NOTE As a `Pipe` (see **4.2.236**) is bent, the wall thickness on the outside portion of the bend will reduce as material stretches.

4.2.349.2 centreline_radius

The `centreline_radius` specifies the radius of the `Swept_bend_pipe` circular arc as measured to the centreline of the Pipe (see 4.2.236).

4.2.349.3 sweep_angle

The `sweep_angle` specifies the subtended angle of the `Swept_bend_pipe` circular arc.

4.2.350. System_space

A `System_space` is a type of `Plant_volume` (see 4.2.278) that is used to describe or allocate a volume of space for use by a `Plant_system` (see 4.2.276).

EXAMPLE Examples of `System_space` type designations include electrical chases, HVAC chases, and instrumentation and control chases.

4.2.351. Tee

A Tee is a type of Fitting (see 4.2.118) that is a single branched outlet Fitting consisting of a straight run and a perpendicular branch used to permit straight-through and 90-degree flow.

NOTE Figure 65 depicts a typical butt-weld Tee.

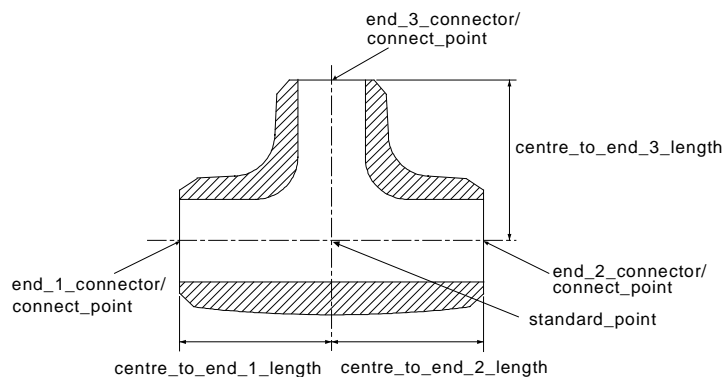


Figure 65 - Tee

The data associated with a Tee are the following:

- `centre_to_end_1_length`;
- `centre_to_end_2_length`;
- `centre_to_end_3_length`;
- `end_1_connector`;
- `end_2_connector`;

4.2.351.1 centre_to_end_1_length

The `centre_to_end_1_length` specifies the distance from the intersection of the Tee straight-run centreline and branch-run centreline to the end-one face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.351.2 centre_to_end_2_length

The `centre_to_end_2_length` specifies the distance from the intersection of the Tee straight-run centreline and branch-run centreline to the end-two face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.351.3 centre_to_end_3_length

The `centre_to_end_3_length` specifies the distance from the intersection of the Tee straight-run centreline and branch-run centreline to the end-three face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.351.4 end_1_connector

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) along the straight-run centreline designated as end one.

4.2.351.5 end_2_connector

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) along the straight-run centreline designated as end two.

4.2.351.6 end_3_connector

The `end_3_connector` specifies the `Piping_connector` (see **4.2.242**) along the branch-run centreline designated as end three.

4.2.352. Threaded

A Threaded is a type of `Piping_connector` (see **4.2.242**) that is a physical feature of a `Plant_item` (see **4.2.260**) that allows partial insertion of a male threaded connector.

NOTE Figure 66 depicts a typical Threaded end.

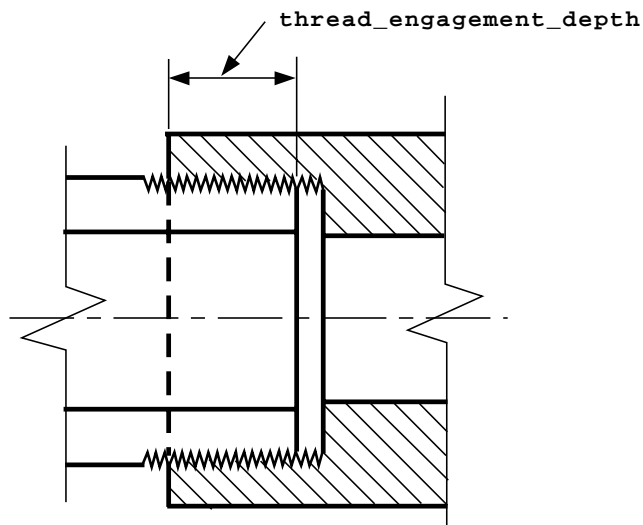


Figure 66 - Threaded

The data associated with a Threaded are the following:

— thread_engagement_depth.

The thread_engagement_depth specifies the insertion distance of the male threaded connector into a female threaded connector.

4.2.353. Threaded_flange

A Threaded_flange is a type of Flange (see 4.2.119) whose bore is Threaded (see 4.2.352) and that is connected to a Pipe (see 4.2.236) by screwing a threaded Pipe end into the Flange.

NOTE Figure 67 depicts a typical Threaded_flange.

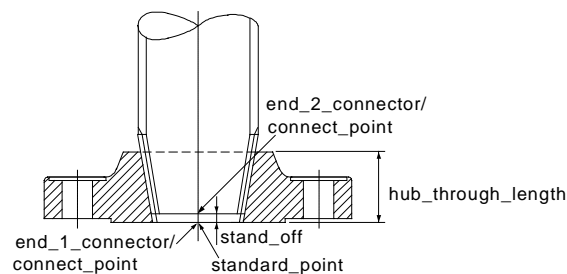


Figure 67 - Threaded_flange

4.2.354. Toothed_lock_washer

ISO/CD 10303-227

A `Toothed_lock_washer` is a type of `Washer` (see **4.2.369**). The `Toothed_lock_washer` has teeth on its outer or inner, or both circular edges. The teeth are bent or twisted to improve electric conductivity when fastened.

The data associated with a `Toothed_lock_washer` are the following:

— `thickness`;

— `outside_diameter`.

4.2.354.1 thickness

The `thickness` specifies the distance between two faces of the material plate of the `Toothed_lock_washer`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.354.2 outside_diameter

The `outside_diameter` specifies the diameter of a circumscribed circle of the `Toothed_lock_washer`. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.355. Torus

A `Torus` is a type of `Csg_element` (see **4.2.84**) that is defined by sweeping the area of a circle (with minor radius) about a larger circle. A `Torus` may be an `Reducing_torus` (see **4.2.294**). A `Torus` may be a `Trimmed_torus` (see **4.2.362**).

4.2.356. Train

A `Train` is a type of `Plant` (see **4.2.258**) that consists of connected `Plant_items` (see **4.2.260**) that perform a distinct function. It is one of two or more distinct but similar portions of a system that perform the same function.

4.2.357. Trimmed_block

A `Trimmed_block` is a type of `Csg_element` (see **4.2.84**) that is formed by cutting a `Block` (see **4.2.7**) with one or more planes and removing one or more of the resulting sections.

4.2.358. Trimmed_cone

A `Trimmed_cone` is a type of `Csg_element` (see **4.2.84**) that is formed by cutting a `Cone` (see **4.2.68**) with one or more planes and removing one or more of the resulting sections.

4.2.359. Trimmed_cylinder

A `Trimmed_cylinder` is a type of `Csg_element` (see **4.2.84**) that is formed by cutting a `Cylinder` (see **4.2.86**) with one or more planes and removing one or more of the resulting sections.

4.2.360. Trimmed_pyramid

A Trimmed_pyramid is a type of Csg_element (see 4.2.84) that is formed by cutting a Pyramid (see 4.2.288) with one or more planes and removing one or more of the resulting sections.

4.2.361. Trimmed_sphere

A Trimmed_sphere is a type of Csg_element (see 4.2.84) that is formed by cutting a Sphere (see 4.2.326) with one or more planes and removing one or more of the resulting sections.

4.2.362. Trimmed_torus

A Trimmed_torus is a type of Csg_element (see 4.2.84) that is formed by cutting a Torus (see 4.2.355) with one or more planes and removing one or more of the resulting sections.

4.2.363. Trunnion

A Trunnion is a type of Piping_support (see 4.2.248) that is attached to a vertical pipe. The main body of the Trunnion is typically pipe, but shape steel or plate is occasionally used as the material of the part. The Trunnion is placed horizontally and supports the weight that acts perpendicularly to the axis of the main body.

NOTE Figure 68 depicts a typical Trunnion.

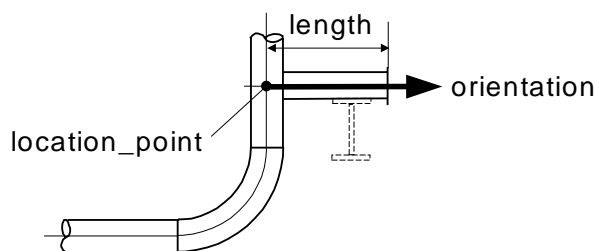


Figure 68 - Trunnion

The data associated with a Trunnion are the following:

— length.

The length specifies the distance between the outer face of the Trunnion and the location_point

4.2.364. Union

A Union is a type of Fitting (see 4.2.118) composed of multiple pieces that allows the joining or separating of piping without rotating the piping. It consists of two internally Threaded (see 4.2.352) ends and a centre piece that draws the two ends together when rotated.

NOTE Figure 69 depicts a typical socket-weld Union.

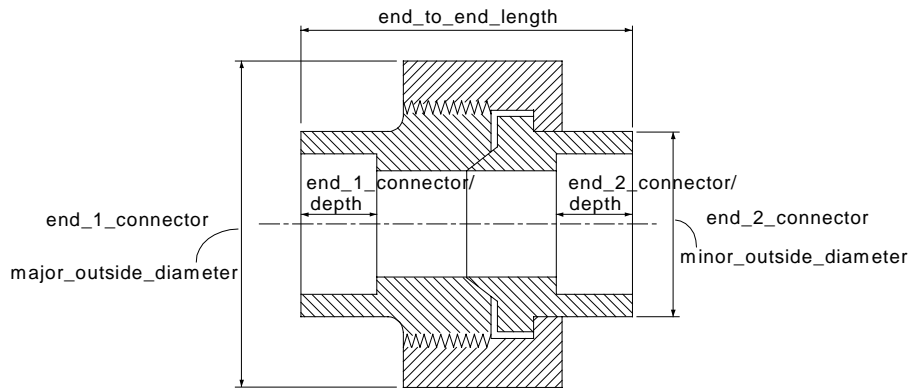


Figure 69 - Union

The data associated with a Union are the following:

- end_1_connector;
- end_2_connector;
- end_to_end_length;
- major_outside_diameter;
- minor_outside_diameter.

4.2.364.1 end_1_connector

The end_1_connector specifies the Piping_connector (see 4.2.242) that corresponds to the end with the major_outside_diameter.

4.2.364.2 end_2_connector

The end_2_connector specifies the Piping_connector (see 4.2.242) that corresponds to the end with the minor_outside_diameter.

4.2.364.3 end_to_end_length

The end_to_end_length specifies the external distance between the end-one face and the end-two face. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.364.4 major_outside_diameter

The major_outside_diameter specifies the maximum diameter of the Union along the centreline, normally at the joint between the two internal pieces of the Union. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.364.5 minor_outside_diameter

The `minor_outside_diameter` specifies the external diameter of the Union at the end-one and end-two connections. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.365. Unit

A Unit is a type of Plant (see **4.2.258**) that is the designation (name or number) for a Plant or portion of a Plant that produces the same product by different means.

NOTE A Unit may perform a unique function for the Plant (see **4.2.258**) such as oxygen production, or there may be several Units that perform the same function such as multiple Units in a power generation installation. The underground or offsite portion of a Plant may be a Unit.

4.2.366. User_defined_attribute_value

A `User_defined_attribute_value` is a name-value pair for any characteristic that is not specified by an explicit attribute of an application object. The `User_defined_attribute_value` enables the exchange of characteristics and their values that are not defined explicitly by an application object attribute.

The data associated with a `User_defined_attribute_value` are the following:

— name;

— value.

4.2.366.1 name

The name specifies a label that characterizes the `User_defined_attribute_value`.

4.2.366.2 value

The value specifies the data for the `User_defined_attribute_value`.

4.2.367. Valve

A Valve is a type of `Piping_component` (see **4.2.240**) that provides isolation or controls fluid direction or flow rate.

The data associated with a Valve are the following:

— `actuator_type`;

— `operation_mode`;

— `type`;

— `valve_stem_orientation`;

— `end_to_end_length`.

4.2.367.1 actuator_type

The `actuator_type` specifies a descriptive designation of device or mechanism used to open, position, or close a Valve.

4.2.367.2 operation_mode

The `operation_mode` specifies the failure mode, as in the state of being open or closed when the actuator either has no power or is in the default position.

4.2.367.3 type

The `type` specifies a designation that classifies a Valve based on its purpose that defines the design of its internals and externals.

EXAMPLE Examples of Valve type designations include gate, globe, check, and relief.

4.2.367.4 valve_stem_orientation

The `valve_stem_orientation` specifies the centreline direction of the Valve stem.

4.2.367.5 end_to_end_length

The `end_to_end_length` specifies the distance between connecting faces of a Valve.

4.2.368. Vector

A Vector is a type of Curve (see **4.2.85**). It specifies a direction in 3D space.

4.2.369. Washer

A Washer is a type of Bolt_and_nut_component (see **4.2.9**) that is used to improve the tightness of a screw fastener. The Washer is a flattened, ring-shaped device.

The data associated with a Washer are the following:

— `washer_type`.

The `washer_type` specifies a classification of the Washer based on its shape characteristics.

EXAMPLE Examples of `washer_type` designations include plain, spring, and toothed_lock.

4.2.370. Weld_neck_flange

A `Weld_neck_flange` is a type of Flange (see **4.2.119**) with a tapered hub bored to match the inside diameter of matching Plant_item (see **4.2.260**) and with the hub beveled for butt welding to the Plant_item.

NOTE Figure 70 depicts a typical Weld-neck flange.

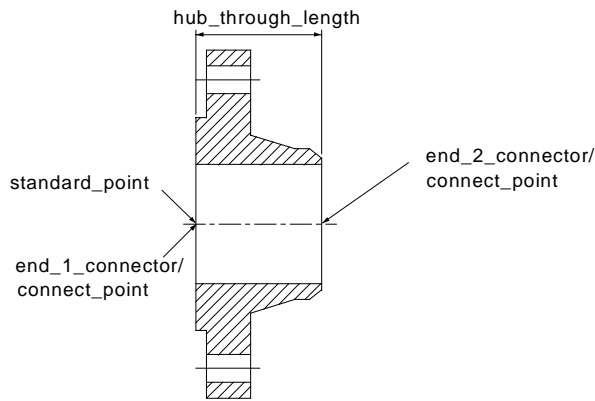


Figure 70 - Weld_neck_flange

4.2.371. Weld_neck_jacket_flange

A **Weld_neck_jacket_flange** is a type of **Weld_neck_flange** (see 4.2.370) that is welded onto a **Piping_spool** (see 4.2.246) that is jacketed closing off the jacket.

NOTE Figure 71 depicts a typical **Weld_neck_jacket_flange**.

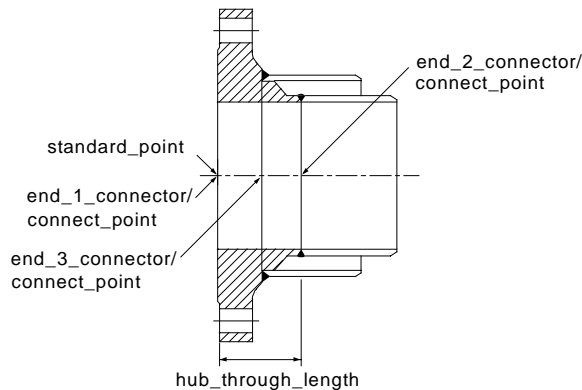


Figure 71 - Weld_neck_jacket_flange

The data associated with a **Weld_neck_jacket_flange** are the following:

— **end_3_connector**.

The **end_3_connector** specifies the **Piping_connector** (see 4.2.242) where the outside Pipe (see 4.2.236) of the jacketed piping connects to the Flange (see 4.2.119).

4.2.372. Wire_and_surface_element

A **Wire_and_surface_element** is a type of **Shape_representation_element** (see 4.2.310) that is composed of geometric elements. Each **Wire_and_surface_element** is either: a **Curve** (see 4.2.85), a **Point** (see 4.2.281), or a **Surface** (see 4.2.347).

4.2.373. Y_type_lateral

ISO/CD 10303-227

A `Y_type_lateral` is a type of Fitting (see **4.2.118**) that is a three-way fitting whose branches are at equal angles from the straight-run centreline forming a flow passage shaped like the letter "Y".

NOTE Figure 72 depicts a typical `Y_type_lateral`.

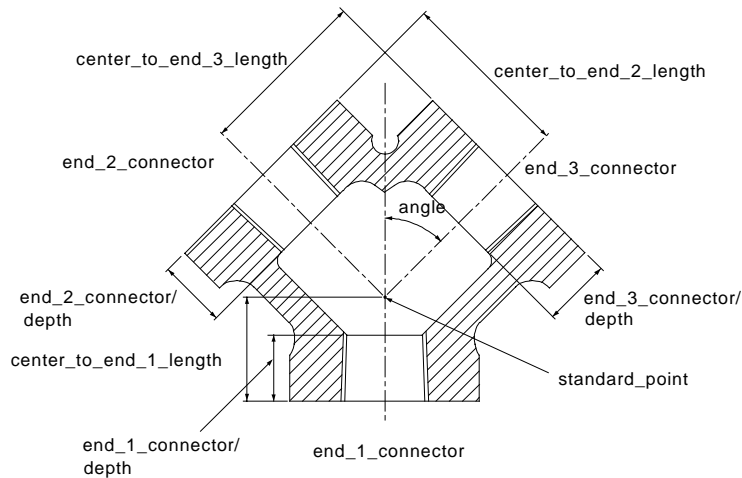


Figure 72 - Y_type_lateral

The data associated with a `Y_type_lateral` are the following:

- `angle`;
- `centre_to_end_1_length`;
- `centre_to_end_2_length`;
- `centre_to_end_3_length`;
- `end_1_connector`;
- `end_2_connector`;
- `end_3_connector`.

4.2.373.1 angle

The `angle` specifies the angle of the branch portions of the `Y_type_lateral` with respect to the straight run. It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.373.2 centre_to_end_1_length

The `centre_to_end_1_length` specifies the distance from the intersection of the `Y_type_lateral` straight-run centreline and branch-run centreline to the end-one working Point (see **4.2.281**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.373.3 centre_to_end_2_length

The `centre_to_end_2_length` specifies the distance from the intersection of the `Y_type_lateral` straight-run centreline and branch-run centreline to the end-two working Point (see **4.2.281**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.373.4 centre_to_end_3_length

The `centre_to_end_3_length` specifies the distance from the intersection of the `Y_type_lateral` straight-run centreline and branch-run centreline to the end-three working Point (see **4.2.281**). It may be specified as a single value or as a range of values.

NOTE See annex L for a discussion of attributes that may be assigned a single value or a range of values.

4.2.373.5 end_1_connector

The `end_1_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end one.

4.2.373.6 end_2_connector

The `end_2_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end two.

4.2.373.7 end_3_connector

The `end_3_connector` specifies the `Piping_connector` (see **4.2.242**) designated as end three.

4.3. Application assertions

This subclause specifies the application assertions for the plant spatial configuration application protocol. Application assertions specify the relationships among application objects, the cardinality of the relationships, and the rules required for the integrity and validity of the application objects and UoFs. The application assertions and their definitions are given below.

4.3.1. Analysis_data_point to Plant_item

Each Analysis_data_point is defined for zero, one or many Plant_item objects. Each Plant_item has zero, one or many Analysis_data_point objects.

4.3.2. Bolt_and_nut_set to Bolt_and_nut_component

Each Bolt_and_nut_set consists of one or more Bolt_and_nut_component objects. Each Bolt_and_nut_component is contained in exactly one Bolt_and_nut_set.

4.3.3. Breakline to Survey_point

Each Breakline is defined by zero, one or many Survey_point objects. Each Survey_point defines zero, one, or many Breakline objects.

4.3.4. Building to Location_in_building

Each Building is a reference frame for zero, one or many Location_in_building objects. Each Location_in_building has a reference frame provided by exactly one Building object.

4.3.5. Building to Reference_geometry

Each Building has column lines defined by zero, one or many Reference_geometry objects. Each Reference_geometry defines column lines for of zero or one Building object.

4.3.6. Cable to Cableway_component

Each Cable runs through zero, one or many Cableway_component objects. Each Cableway_component contains zero, one or many Cable objects.

4.3.7. Cableway_size_description to Cableway_component

Each Cableway_size_description describes size of zero, one or many Cableway_component objects. Each Cableway_component has a size described by exactly one Cableway_size_description object.

4.3.8. Catalogue_connector to Connector_definition

Each Catalogue_connector defines zero, one or many Connector_definition objects. . Each Connector_definition is defined by zero or one Catalogue_connector object.

4.3.9. Catalogue_definition to Catalogue_connector

Each Catalogue_definition contains zero, one or many Catalogue_connector objects. Each Catalogue_connector is contained by exactly one Catalogue_definition object.

4.3.10. Catalogue_definition to Catalogue_item

Each Catalogue_definition contains zero, one or many Catalogue_item objects. Each Catalogue_item is contained by exactly one Catalogue_definition object.

4.3.11. Catalogue_item to Catalogue_item_substitute

Each Catalogue_item has zero, one or many Catalogue_item_substitute objects. Each Catalogue_item_substitute is exactly one Catalogue_item object.

Each Catalogue_item is a substitute in zero, one or many Catalogue_item_substitute objects. Each Catalogue_item_substitute identifies a substitute for exactly one Catalogue_item object.

4.3.12. Catalogue_item to Plant_item_definition

Each Catalogue_item defines zero or one Plant_item_definition objects. Each Plant_item_definition is defined by zero or one Catalogue_item object.

4.3.13. Change to Change_item

Each Change changes one or more Change_item objects. Each Change_item is changed by zero, one, or many Change objects.

4.3.14. Change to Change_life_cycle_stage_usage

Each Change is assigned by one or more Change_life_cycle_stage_usage objects. Each Change_life_cycle_stage_usage assigns exactly one Change.

4.3.15. Change_life_cycle_stage to Change_life_cycle_stage_sequence

Each Change_life_cycle_stage is the predecessor in zero or one Change_life_cycle_stage_sequence objects. Each Change_life_cycle_stage_sequence has exactly one Change_life_cycle_stage as the predecessor.

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Each `Change_life_cycle_stage` is the successor in zero, one or many `Change_life_cycle_stage_sequence` objects. Each `Change_life_cycle_stage_sequence` has exactly one `Change_life_cycle_stage` as the successor.

4.3.16. Change_life_cycle_stage to Change_life_cycle_stage_usage

Each `Change_life_cycle_stage` has changes assigned by zero or one `Change_life_cycle_stage_usage` objects. Each `Change_life_cycle_stage_usage` assigns changes for exactly one `Change_life_cycle_stage`.

4.3.17. Change_life_cycle_stage_usage to Change_approval

Each `Change_life_cycle_stage_usage` is approved by zero or one `Change_approval` objects. Each `Change_approval` approves exactly one `Change_life_cycle_stage_usage`.

4.3.18. Clamp_set to Bolt_and_nut_component

Each `Clamp_set` consists of one or more `Bolt_and_nut_component` objects. Each `Bolt_and_nut_component` is associated with zero or one `Clamp_set`.

4.3.19. Clamp_set to Clamp

Each `Clamp_set` consists of one or more `Clamp` objects. Each `Clamp` is associated with exactly one `Clamp_set`.

4.3.20. Connected_collection to Plant_item_connection

Each `Connected_collection` contains zero, one or many `Plant_item_connection` objects. Each `Plant_item_connection` participates in zero, one or many `Connected_collection` objects.

4.3.21. Connection_definition to Connector_definition

Each `Connection_definition` connects two or more `Connector_definition` objects. Each `Connector_definition` is connected by exactly one `Connection_definition` object.

4.3.22. Connection_definition to Functional_connection_definition_satisfaction

Each `Connection_definition` is functional requirements for zero, one or many `Functional_connection_definition_satisfaction` objects. Each `Functional_connection_definition_satisfaction` gets the functional requirements from exactly one `Connection_definition` object.

Each Connection_definition satisfies requirements for zero, one or many Functional_connection_definition_satisfaction objects. Each Functional_connection_definition_satisfaction has requirements satisfied by exactly one Connection_definition object.

4.3.23. Connection_definition to Plant_item_connection_occurrence

Each Connection_definition defines zero, one or many Plant_item_connection_occurrence objects. Each Plant_item_connection_occurrence is defined by zero or one Connection_definition object.

4.3.24. Connection_material to Bolt_and_nut_set

Each Connection_material includes zero, one or many Bolt_and_nut_set objects. Each Bolt_and_nut_set is used in zero, one or many Connection_material objects.

4.3.25. Connection_material to Clamp_set

Each Connection_material includes zero, one or many Clamp_set objects. Each Clamp_set is used in zero, one or many Connection_material objects.

4.3.26. Connector_definition to Catalogue_connector

Each Connector_definition is used as zero, one or many Catalogue_connector objects. Each Catalogue_connector is zero or one Connector_definition object.

4.3.27. Connector_definition to Functional_connector_definition_satisfaction

Each Connector_definition satisfies requirements for zero, one or many Functional_connector_definition_satisfaction objects. Each Functional_connector_definition_satisfaction has requirements satisfied by exactly one Connector_definition object.

Each Connector_definition is functional requirements for zero, one or many Functional_connector_definition_satisfaction objects. Each Functional_connector_definition_satisfaction gets the functional requirements from exactly one Connector_definition object.

4.3.28. Connector_definition to Plant_item_connector_occurrence

Each Connector_definition defines zero, one or many Plant_item_connector_occurrence objects. Each Plant_item_connector_occurrence is defined by zero or one Connector_definition object.

4.3.29. Design_project to Project_design_assignment

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Each Design_project is performed in one or more Project_design_assignment objects. Each Project_design_assignment assigns a task to exactly one Design_project object.

4.3.30. Document to Connection_inspection_record

Each Document has inspection information defined by zero, one or many Connection_inspection_record objects. Each Connection_inspection_record defines inspection information for zero, one or many Document objects.

4.3.31. Document to Piping_spool_inspection_record

Each Document has inspection information defined by zero, one or many Piping_spool_inspection_record objects. Each Piping_spool_inspection_record defines inspection information for zero, one or many Document objects.

4.3.32. Ducting_system to Stream_design_case

Each Ducting_system transports material for zero, one or many Stream_design_case objects. Each Stream_design_case defines potential material for zero, one or many Ducting_system objects.

4.3.33. Equipment to Equipment_trim_piping

Each Equipment requires zero, one or many Equipment_trim_piping objects. Each Equipment_trim_piping is required by exactly one Equipment object.

4.3.34. Equipment to Supplied_equipment

Each Equipment is used as zero, one or many Supplied_equipment objects. Each Supplied_equipment is exactly one Equipment object.

4.3.35. Facet_trigon to Survey_point

Each Facet_trigon is defined by exactly three Survey_point objects. Each Survey_point defines zero, one or many Facet_trigon objects.

4.3.36. Faceted_surface_representation to Facet_trigon

Each Faceted_surface_representation is composed of one or more Facet_trigon objects. Each Facet_trigon is a component of exactly one Faceted_surface_representation object.

4.3.37. Functional_connector to Functional_connector_occurrence_satisfaction

Each Functional_connector is the functional requirements for zero, one, or many Functional_connector_occurrence_satisfaction objects. Each Functional_connector_occurrence_satisfaction gets the functional requirements from exactly one Functional_connector object.

4.3.38. Functional_design_view to Functional_plant_item_satisfaction

Each Functional_design_view is functional requirements for zero, one or many Functional_plant_item_satisfaction objects. Each Functional_plant_item_satisfaction gets the functional requirements from exactly one Functional_design_view object.

4.3.39. Functional_plant to Functional_plant_satisfaction

Each Functional_plant is functional requirements for zero, one or many Functional_plant_satisfaction objects. Each Functional_plant_satisfaction gets the functional requirements from exactly one Functional_plant object.

4.3.40. Functional_plant to Plant_system

Each Functional_plant is made up of zero, one or many Plant_system objects. Each Plant_system is part of exactly one Functional_plant object.

4.3.41. Functional_design_view to Functional_plant_item_satisfaction

Each Functional_design_view is the functional requirements for zero, one or many Functional_plant_item_satisfaction. Each Functional_plant_item_satisfaction gets the functional requirements from exactly one Functional_design_view.

4.3.42. Hvac_component to Hvac_access_opening

Each Hvac_component object is accessed through zero, one or many Hvac_access_opening objects. Each Hvac_access_opening object belongs to exactly one Hvac_component object.

4.3.43. Hvac_component to Hvac_component_thickness

Each Hvac_component has skin thickness of zero, one or many Hvac_component_thickness objects. Each Hvac_component_thickness defines the skin thickness for exactly one Hvac_component object.

4.3.44. Hvac_connector to Hvac_connector_service_characteristic

Each Hvac_connector has zero, one or many Hvac_connector_service_characteristic objects. Each Hvac_connector_service_characteristic belongs to exactly one Hvac_connector object.

4.3.45. Hvac_connector to Hvac_cross_section

Each Hvac_connector defines cross section of zero, one or many Hvac_cross_section objects. Each Hvac_cross_section is defined by exactly one Hvac_connector object.

4.3.46. Hvac_connector_service_characteristic to Service_operating_case

Each Hvac_connector_service_characteristic supports zero, one or many Service_operating_case objects. Each Service_operating_case is associated with exactly one Hvac_connector_service_characteristic object.

4.3.47. Hvac_elbow_90deg_reducing to Splitter

Each Hvac_elbow_90deg_reducing has zero, one or many Splitter objects. Each Splitter reduces the potential turbulence for exactly one Hvac_elbow_90deg_reducing.

4.3.48. Hvac_elbow_centred to Splitter

Each Hvac_elbow_centred has zero, one or many Splitter objects. Each Splitter reduces the potential turbulence for exactly one Hvac_elbow_centred.

4.3.49. Hvac_elbow_mitre to Splitter

Each Hvac_elbow_mitre has zero, one or many Splitter objects. Each Splitter reduces the potential turbulence for exactly one Hvac_elbow_mitre.

4.3.50. Hvac_equipment to Hvac_flow_control_device

Each Hvac_equipment object is controlled by zero, one or many Hvac_flow_control_device objects. Each Hvac_flow_control_device object controls zero, one or many Hvac_equipment objects.

4.3.51. Hvac_instrument to Hvac_flow_control_device

Each Hvac_instrument object provides data for zero, one or many Hvac_flow_control_device objects. Each Hvac_flow_control_device object is associated with zero or one Hvac_instrument objects.

4.3.52. Hvac_offset_centred to Splitter

Each Hvac_offset_centred has zero, one or many Splitter objects. Each Splitter reduces the potential turbulence for exactly one Hvac_offset_centred.

4.3.53. Hvac_plant_item_branch_connector to Hvac_plant_item_branch_connection

Each Hvac_plant_item_branch_connector is connected to zero or one Hvac_plant_item_branch_connection. Each Hvac_plant_item_branch_connection is associated with exactly one Hvac_plant_item_branch_connector.

4.3.54. Hvac_plant_item_connector to Hvac_plant_item_connection

Each Hvac_plant_item_connector is connected to exactly two Hvac_plant_item_connection objects. Each Hvac_plant_item_connection is associated with exactly one Hvac_plant_item_connector.

4.3.55. Hvac_plant_item_termination to Hvac_plant_item_connection

Each Hvac_plant_item_termination is connected to exactly one Hvac_plant_item_connection. Each Hvac_plant_item_connection is associated with exactly one Hvac_plant_item_termination.

4.3.56. Hvac_section_branch_termination to Hvac_branch_connection

Each Hvac_section_branch_termination branches from zero, one or many Hvac_branch_connection objects. Each Hvac_branch_connection is associated with exactly one Hvac_section_branch_termination.

4.3.57. Hvac_section_segment to Hvac_branch_connection

Each Hvac_section_segment is connected to zero, one or many Hvac_branch_connection objects. Each Hvac_branch_connection is associated with exactly one Hvac_section_segment.

4.3.58. Hvac_section_segment to Hvac_plant_item_branch_connection

Each Hvac_section_segment is connected to zero, one or many Hvac_plant_item_branch_connection objects. Each Hvac_plant_item_branch_connection is associated with exactly one Hvac_section_segment.

4.3.59. Hvac_section_segment to Hvac_section_segment_insulation

Each Hvac_section_segment has zero, one or many Hvac_section_segment_insulation objects. Each Hvac_section_segment_insulation is associated with exactly one Hvac_section_segment.

4.3.60. Hvac_section_segment to Hvac_section_segment_termination

Each Hvac_section_segment is terminated by exactly two Hvac_section_segment_termination objects. Each Hvac_section_segment_termination is associated with exactly one Hvac_section_segment.

4.3.61. Hvac_section_segment to Hvac_section_termination

Each Hvac_section_segment is started or ended by zero, one, or two Hvac_section_termination objects. Each Hvac_section_termination is associated with exactly one Hvac_section_segment.

4.3.62. Hvac_section_segment to Stream_design_case

Each Hvac_section_segment transports material for zero, one or many Stream_design_case objects. Each Stream_design_case defines potential material for zero, one or many Hvac_section_segment objects.

4.3.63. Hvac_section_to_section_connection to Hvac_section_to_section_termination

Each Hvac_section_to_section_connection connects zero, one or many Hvac_section_to_section_termination objects. Each Hvac_section_to_section_termination is associated with zero or one Hvac_section_to_section_connection objects.

4.3.64. Hvac_specification to Hvac_section_segment

Each Hvac_specification specifies components for zero, one or many Hvac_section_segment objects. Each Hvac_section_segment has components specified by exactly one Hvac_specification object.

4.3.65. Hvac_system_section to Hvac_section_segment

Each Hvac_system_section has at least one Hvac_section_segment object. Each Hvac_section_segment is associated with exactly one Hvac_system_section.

4.3.66. Inspection_condition to Connection_inspection_record

Each Inspection_condition is specified under zero, one or many Connection_inspection_record objects. Each Connection_inspection_record defines the environment for zero, one or many Inspection_condition objects.

4.3.67. Inspection_condition to Piping_component_inspection_record

Each Inspection_condition is specified under zero, one or many Piping_component_inspection_record objects. Each Piping_component_inspection_record defines the environment for zero, one or many Inspection_condition objects.

4.3.68. Line_branch_connection to Changed_line_branch_connection

Each Line_branch_connection is changed by zero, one, or many Changed_line_branch_connection objects. Each Changed_line_branch_connection changes exactly one Line_branch_connection.

4.3.69. Line_branch_termination to Line_branch_connection

Each Line_branch_termination is branched from exactly one Line_branch_connection object.
Each Line_branch_connection branches to exactly one Line_branch_termination object.

4.3.70. Line_less_piping_system to Piping_system_component

Each Line_less_piping_system is composed of zero, one or many Piping_system_component objects. Each Piping_system_component is a component of zero, one or many Line_less_piping_system objects.

4.3.71. Line_less_piping_system to Stream_design_case

Each Line_less_piping_system transports material for zero, one, or many Stream_design_case objects. Each Stream_design_case defines potential material for zero, one, or many Line_less_piping_system objects.

4.3.72. Line_piping_system_component_assignment to Changed_line_assignment

Each Line_piping_system_component_assignment is changed by zero, one, or many Changed_line_assignment objects. Each Changed_line_assignment changes exactly one Line_piping_system_component_assignment.

4.3.73. Line_plant_item_branch_connection to Changed_line_plant_item_branch_connection

Each Line_plant_item_branch_connection is changed by zero, one, or many Changed_line_plant_item_branch_connection objects. Each Changed_line_plant_item_branch_connection changes exactly one Line_plant_item_branch_connection.

4.3.74. Line_plant_item_branch_connector to Line_plant_item_branch_connection

Each Line_plant_item_branch_connector is connected to zero or one Line_plant_item_branch_connection object. Each Line_plant_item_branch_connection connects exactly one Line_plant_item_branch_connector object.

4.3.75. Line_plant_item_connection to Changed_line_plant_item_connection

Each Line_plant_item_connection is changed by zero, one, or many Changed_line_plant_item_connection objects. Each Changed_line_plant_item_connection changes exactly one Line_plant_item_connection.

4.3.76. Line_plant_item_connector to Line_plant_item_connection

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Each Line_plant_item_connector is connected to zero or one Line_plant_item_connection object.
Each Line_plant_item_connection connects exactly one Line_plant_item_connector object.

4.3.77. Line_plant_item_termination to Line_plant_item_connection

Each Line_plant_item_termination is connected to exactly one Line_plant_item_connection object. Each Line_plant_item_connection connects exactly one Line_plant_item_termination object.

4.3.78. Line_to_line_connection to Changed_line_to_line_connection

Each Line_to_line_connection is changed by zero, one or many Changed_line_to_line_connection objects. Each Changed_line_to_line_connection changes exactly one Line_to_line_connection object.

4.3.79. Line_to_line_connection to Line_to_line_termination

Each Line_to_line_connection connects two or more Line_to_line_termination objects. Each Line_to_line_termination is connected by exactly one Line_to_line_connection object.

4.3.80. Material_specification_selection to Material_specification_subset_reference

Each Material_specification_selection is used by zero, one or many Material_specification_subset_reference objects. Each Material_specification_subset_reference uses exactly one Material_specification_selection object.

4.3.81. Node to Piping_system

Each Node contains zero, one or many Piping_system objects. Each Piping_system defines branch point for zero, one or many Node objects.

4.3.82. Physical_connector to Functional_connector_occurrence_satisfaction

Each Physical_connector satisfies requirements for zero, one or many Functional_connector_occurrence_satisfaction objects. Each Functional_connector_occurrence_satisfaction has requirements satisfied by exactly one Physical_connector object.

4.3.83. Physical_design_view to Functional_plant_item_satisfaction

Each Physical_design_view satisfies requirements for zero, one or many Functional_plant_item_satisfaction objects. Each Functional_plant_item_satisfaction has requirements satisfied by exactly one Physical_design_view object.

4.3.84. Physical_design_view to Installed_physical_design_view

Each Physical_design_view is used as zero or one Installed_physical_design_view object. Each Installed_physical_design_view is exactly one Physical_design_view object.

4.3.85. Piping_assembly to Piping_assembly_assignment

Each Piping_assembly is in zero, one or many Piping_assembly_assignment objects. Each piping_assembly_assignment assembles exactly one Piping_assembly.

4.3.86. Piping_component to Family_definition

Each Piping_component defines zero or one Family_definition object. Each Family_definition is defined by zero or one Piping_component object.

4.3.87. Piping_component to Piping_component_inspection_record

Each Piping_component has zero, one or many Piping_component_inspection_record objects. Each Piping_component_inspection_record belongs to exactly one Piping_component object.

4.3.88. Piping_component_inspection_record to Document

Each Piping_component_inspection_record has inspection information defined by zero, one or many Document objects. Each Document defines inspection information for zero, one or many Piping_component_inspection_record objects.

**4.3.89. Piping_connector to
Piping_connector_service_characteristic**

Each Piping_connector provides zero or one Piping_connector_service_characteristic object. Each Piping_connector_service_characteristic is provided by exactly one Piping_connector object.

4.3.90. Piping_connector to Piping_size_description

Each Piping_connector has a size described by zero, one or many Piping_size_description objects. Each Piping_size_description describes the size of zero, one or many Piping_connector objects.

**4.3.91. Piping_connector_service_characteristic to
Service_operating_case**

Each Piping_connector_service_characteristic supports zero, one or many Service_operating_case objects. Each Service_operating_case is supported by exactly one Piping_connector_service_characteristic object.

4.3.92. Piping_specification to Changed_piping_specification

Each Piping_specification is changed by zero, one, or many Changed_piping_specification objects. Each Changed_piping_specification changes exactly one Piping_specification.

4.3.93. Piping_specification to Family_definition

Each Piping_specification is composed of one or more Family_definition objects. Each Family_definition is part of exactly one Piping_specification object.

4.3.94. Piping_specification to Piping_system_line_segment

Each Piping_specification specifies components for zero, one or many Piping_system_line_segment objects. Each Piping_system_line_segment has components specified by exactly one Piping_specification object.

4.3.95. Piping_spool to Piping_spool_inspection_record

Each Piping_spool has zero, one or many Piping_spool_inspection_record objects. Each Piping_spool_inspection_record is part of exactly one Piping_spool object.

4.3.96. Piping_spool to Shape_inspection_record

Each Piping_spool has zero, one or many Shape_inspection_record objects. Each Shape_inspection_record is part of zero or one Piping_spool object.

4.3.97. Piping_spool_inspection_record to Inspection_condition

Each Piping_spool_inspection_record is specified under zero, one or many Inspection_condition objects. Each Inspection_condition defines the environment for zero, one or many Piping_spool_inspection_record objects.

4.3.98. Piping_system to Piping_system_line

Each Piping_system is made up of zero, one or many Piping_system_line objects. Each Piping_system_line is part of exactly one Piping_system object.

4.3.99. Piping_system_component to Equipment_trim_piping

Each Piping_system_component is used as zero, one or many Equipment_trim_piping objects. Each Equipment_trim_piping is exactly one Piping_system_component object.

4.3.100. Piping_system_component to Line_piping_system_component_assignment

Each Piping_system_component satisfies zero, one or many Line_piping_system_component_assignment objects. Each Line_piping_system_component_assignment is satisfied by exactly one Piping_system_component object.

4.3.101. Piping_system_component to Piping_size_description

Each Piping_system_component has a size described by zero, one or many Piping_size_description objects. Each Piping_size_description describes the size of zero, one or many Piping_system_component objects.

4.3.102. Piping_system_line to Changed_piping_system_line

Each Piping_system_line is changed by zero, one, or many Changed_piping_system_line objects. Each Changed_piping_system_line changes exactly one Piping_system_line.

4.3.103. Piping_system_line to Piping_system_line_segment

Each Piping_system_line is composed of one or more Piping_system_line_segment objects. Each Piping_system_line_segment is a component of exactly one Piping_system_line object.

4.3.104. Piping_system_line to Piping_system_line_termination

Each Piping_system_line is start or ended by zero, one or two Piping_system_line_termination objects. Each Piping_system_line_termination starts or ends exactly one Piping_system_line object.

**4.3.105. Piping_system_line_segment to
Changed_piping_system_line_segment**

Each Piping_system_line_segment is changed by zero, one, or many Changed_piping_system_line_segment objects. Each Changed_piping_system_line_segment changes exactly one Piping_system_line_segment.

4.3.106. Piping_system_line_segment to Line_branch_connection

Each Piping_system_line_segment has branches defined by zero, one or many Line_branch_connection objects. Each Line_branch_connection defines the branches of exactly one Piping_system_line_segment object.

**4.3.107. Piping_system_line_segment to
Line_plant_item_branch_connection**

Each Piping_system_line_segment is connected to zero, one, or many Line_plant_item_branch_connection objects. Each Line_plant_item_branch_connection defines the branches of exactly one Piping_system_line_segment.

**4.3.108. Piping_system_line_segment to
Line_piping_system_component_assignment**

Each Piping_system_line_segment defines the need for zero, one or many Line_piping_system_component_assignment objects. Each Line_piping_system_component_assignment satisfies the need defined by exactly one Piping_system_line_segment object.

4.3.109. Piping_system_line_segment to Piping_system_line_segment_termination

Each Piping_system_line_segment is terminated by exactly two Piping_system_line_segment_termination objects; one is termination_1 and the other is termination_2. Each Piping_system_line_segment_termination terminates exactly one Piping_system_line_segment object.

4.3.110. Piping_system_line_segment to Segment_insulation

Each Piping_system_line_segment requires zero, one or many Segment_insulation objects. Each Segment_insulation is required by exactly one Piping_system_line_segment object.

4.3.111. Piping_system_line_segment to Stream_design_case

Each Piping_system_line_segment defines transport needs for zero, one, or many Stream_design_case objects. Each Stream_design_case defines potential material for zero, one, or many Piping_system_line_segment objects.

4.3.112. Piping_system_line_segment_termination to Changed_piping_system_line_segment_termination

Each Piping_system_line_segment_termination is changed by zero, one, or many Changed_piping_system_line_segment_termination objects. Each Changed_piping_system_line_segment_termination changes exactly one Piping_system_line_segment_termination.

4.3.113. Planned_physical_plant to Changed_planned_physical_plant

Each Planned_physical_plant is changed by zero, one, or many Changed_planned_physical_plant objects. Each Changed_planned_physical_plant changes exactly one Planned_physical_plant.

4.3.114. Planned_physical_plant to Functional_plant_satisfaction

Each Planned_physical_plant satisfies requirements for zero, one or many Functional_plant_satisfaction objects. Each Functional_plant_satisfaction has requirements satisfied by exactly one Planned_physical_plant object.

4.3.115. Planned_physical_plant to Location_in_plant

Each Planned_physical_plant contains zero, one or many Location_in_plant objects. Each Location_in_plant is located in zero, one or many Planned_physical_plant objects.

4.3.116. Planned_physical_plant to Sited_plant

Each Planned_physical_plant is used as zero or one Sited_plant object. Each Sited_plant is exactly one Planned_physical_plant object.

4.3.117. Planned_physical_plant_item to Piping_assembly_assignment

Each Planned_physical_plant_item is assigned by zero or one Piping_assembly_assignment object. Each Piping_assembly_assignment assigns exactly one Planned_physical_plant_item object.

4.3.118. Planned_physical_plant_item to Plant_item_connector_occurrence

Each Planned_physical_plant_item has zero, one or many Plant_item_connector_occurrence objects. Each Plant_item_connector_occurrence is part of exactly one Planned_physical_plant_item object.

4.3.119. Planned_physical_plant_item to Support_usage

Each Planned_physical_plant_item is supported by zero, one or many Support_usage objects. Each Support_usage identifies exactly one Planned_physical_plant_item object that supports another.

Each Planned_physical_plant_item supports zero, one or many Support_usage objects. Each Support_usage identifies exactly one Planned_physical_plant_item object that is supported.

4.3.120. Plant to Changed_plant

Each Plant is changed by zero, one, or many Changed_plant objects. Each Changed_plant changes exactly one Plant.

4.3.121. Plant to External_classification

Each Plant is classified by zero, one or many External_classification objects. Each External_classification classifies zero, one or many Plant objects.

4.3.122. Plant to Functional_plant

Each Plant is used as zero or one Functional_plant object. Each Functional_plant is exactly one Plant object.

4.3.123. Plant to Planned_physical_plant

Each Plant is realized as zero, one or many Planned_physical_plant objects. Each Planned_physical_plant is the realization of exactly one Plant object.

4.3.124. Plant to Plant_process_capability

Each Plant produces zero, one or many Plant_process_capability objects. Each Plant_process_capability is produced by exactly one Plant object.

4.3.125. Plant to Sub_plant_relationship

Each Plant contains zero, one or many Sub_plant_relationship objects. Each Sub_plant_relationship is contained in exactly one Plant object.

Each Plant is used in zero, one or many Sub_plant_relationship objects. Each Sub-plant_relationship uses exactly one Plant object.

4.3.126. Plant_item to Changed_plant_item

Each Plant_item is changed by zero, one, or many Changed_plant_item objects. Each Changed_plant_item changes exactly one Plant_item.

4.3.127. Plant_item to Document

Each Plant_item has reference of zero, one or many Document objects. Each Document is reference for zero, one or many Plant_item objects.

4.3.128. Plant_item to External_classification

Each Plant_item is classified by zero, one or many External_classification objects. Each External_classification classifies zero, one or many Plant_item objects.

4.3.129. Plant_item to Insulation

Each Plant_item is insulated by zero, one or many Insulation objects. Each Insulation insulates zero or one Plant_item object.

4.3.130. Plant_item to Plant_item_collection

Each Plant_item is a group of zero, one, or many Plant_item_collection objects. Each Plant_item_collection identifies as a group exactly one Plant_item object.

Each Plant_item is an element in zero, one or many Plant_item_collection objects. Each Plant_item_collection identifies as an element of a collection exactly one Plant_item object.

4.3.131. Plant_item to Plant_item_design_view

Each Plant_item is defined as one or more Plant_item_design_view objects. Each Plant_item_design_view defines exactly one Plant_item object.

4.3.132. Plant_item to Plant_item_shape

Each Plant_item is spatially described by zero or one Plant_item_shape object. Each Plant_item_shape spatially describes exactly one Plant_item object.

4.3.133. Plant_item to Plant_item_weight

Each Plant_item is measured as having zero, one or many Plant_item_weight objects. Each Plant_item_weight is the measured weight of exactly one Plant_item object.

4.3.134. Plant_item to Reference_geometry

Each Plant_item references zero, one or many Reference_geometry objects. Each Reference_geometry is referenced by zero, one or many Plant_item objects.

4.3.135. Plant_item to Required_material_description

Each Plant_item satisfies zero, one or many Required_material_description objects. Each Required_material_description is satisfied by zero, one or many Plant_item objects.

4.3.136. Plant_item to Spare_plant_item_usage

Each Plant_item is the primary plant item in zero, one or many Spare_plant_item_usage objects. Each Spare_plant_item_usage has as a primary plant item exactly one Plant_item object.

Each Plant_item is the spare plant item in zero, one or many Spare_plant_item_usage objects. Each Spare_plant_item_usage has as a spare plant item exactly one Plant_item object.

4.3.137. Plant_item to User_defined_attribute_value

Each Plant_item is characterized by zero, one or many User_defined_attribute_value objects. Each User_defined_attribute_value characterizes exactly one Plant_item object.

4.3.138. Plant_item_collection to Changed_plant_item_collection

Each Plant_item_collection is changed by zero, one, or many Changed_plant_item_collection objects. Each Changed_plant_item_collection changes exactly one Plant_item_collection.

4.3.139. Plant_item_connection to Changed_plant_item_connection

Each Plant_item_connection is changed by zero, one, or many Changed_plant_item_connection objects. Each Changed_plant_item_connection changes exactly one Plant_item_connection.

4.3.140. Plant_item_connection to Connection_inspection_record

Each Plant_item_connection has zero, one or many Connection_inspection_record objects. Each Connection_inspection_record is part of exactly one Plant_item_connection object.

4.3.141. Plant_item_connection to Connection_material

Each Plant_item_connection uses one or more Connection_material objects. Each Connection_material is used by exactly one Plant_item_connection object.

4.3.142. Plant_item_connection_occurrence to Functional_connection_occurrence_satisfaction

Each Plant_item_connection_occurrence is the functional requirements for zero, one or many Functional_connection_occurrence_satisfaction objects. Each Functional_connection_occurrence_satisfaction gets the functional requirements from exactly one Plant_item_connection_occurrence object.

Each Plant_item_connection_occurrence satisfies the requirements for zero, one or many Functional_connection_occurrence_satisfaction objects. Each Functional_connection_occurrence_satisfaction has requirements satisfied by exactly one Plant_item_connection_occurrence object.

4.3.143. Plant_item_connection_occurrence to Plant_item_connector_occurrence

Each Plant_item_connection_occurrence connects two or more Plant_item_connector_occurrence objects. Each Plant_item_connector_occurrence is connected by zero or one Plant_item_connection_occurrence object.

4.3.144. Plant_item_connector to Changed_plant_item_connector

Each Plant_item_connector is changed by zero, one, or many Changed_plant_item_connector objects. Each Changed_plant_item_connector changes exactly one Plant_item_connector.

4.3.145. Plant_item_connector to Document

Each Plant_item_connector has reference of zero, one or many Document objects. Each Document is reference for zero, one or many Plant_item_connector objects.

4.3.146. Plant_item_connector to External_classification

Each Plant_item_connector is classified by zero, one or many External_classification objects. Each External_classification classifies zero, one or many Plant_item_connector objects.

4.3.147. Plant_item_connector to Piping_component_inspection_record

Each Plant_item_connector has zero, one or many Piping_component_inspection_record objects. Each Piping_component_inspection_record is part of exactly one Plant_item_connector object.

4.3.148. Plant_item_connector to Required_material_description

Each Plant_item_connector has material requirements defined by zero, one or many Required_material_description objects. Each Required_material_description defines material requirements for zero, one or many Plant_item_connector objects.

4.3.149. Plant_item_connector to Shape_representation

Each Plant_item_connector has shape defined by zero, one or many Shape_representation objects. Each Shape_representation defines the shape of zero, one or many Plant_item_connector objects.

4.3.150. Plant_item_definition to Catalogue_item

Each Plant_item_definition is used as zero, one or many Catalogue_item objects. Each Catalogue_item is zero or one Plant_item_definition object.

4.3.151. Plant_item_definition to Connector_definition

Each Plant_item_definition has one or more Connector_definition objects. Each Connector_definition is part of zero or one Plant_item_definition object.

4.3.152. Plant_item_definition to Planned_physical_plant_item

Each Plant_item_definition defines zero, one or many Planned_physical_plant_item objects. Each Planned_physical_plant_item is defined by zero or one Plant_item_definition object.

4.3.153. Plant_item_instance to Plant_item_interference

Each Plant_item_instance is the first item in zero, one or many Plant_item_interference objects. Each Plant_item_interference has as its first item exactly one Plant_item_instance object.

Each Plant_item_instance is the second item in zero, one or many Plant_item_interference objects. Each Plant_item_interference has as its second item exactly one Plant_item_instance object.

4.3.154. Plant_item_instance to Plant_item_location

Each Plant_item_instance is located by zero or one Plant_item_location object. Each Plant_item_location locates exactly one Plant_item_instance object. A Plant_item_instance shall be located only once in either a plant, site, or building or multiple times with respect to other Plant_item objects. A Plant_item_instance shall not be located more than once in a plant, site, or building.

4.3.155. Plant_item_instance to Project_design_assignment

Each Plant_item_instance is assigned by zero, one or many Project_design_assignment objects. Each Project_design_assignment assigns exactly one Plant_item_instance object.

4.3.156. Plant_item_instance to Relative_item_location

Each Plant_item_instance is the referenced item for zero, one or many Relative_item_location objects. Each Relative_item_location references exactly one Plant_item_instance object.

4.3.157. Plant_item_interference to Interfering_shape_element

Each Plant_item_interference has intersecting geometry of zero, one or many Interfering_shape_element objects. Each Interfering_shape_element is the intersecting geometry for exactly one Plant_item_interference object.

4.3.158. Plant_item_interference to Plant_item_interference_status

Each Plant_item_interference has a status of one or more Plant_item_interference_status objects. Each Plant_item_interference_status provides the status for exactly one Plant_item_interference object.

4.3.159. Plant_item_interference to Shape_interference_zone_usage

Each Plant_item_interference has a zone of interference defined by zero, one or many Shape_interference_zone_usage objects. Each Shape_interference_zone_usage defines the zone of interference for exactly one Plant_item_interference object.

4.3.160. Plant_item_location to Changed_plant_item_location

Each Plant_item_location is changed by zero, one, or many Changed_plant_item_location objects. Each Changed_plant_item_location changes exactly one Plant_item_location.

4.3.161. Plant_item_shape to Changed_plant_item_shape

Each Plant_item_shape is changed by zero, one, or many Changed_plant_item_shape objects. Each Changed_plant_item_shape changes exactly one Plant_item_shape.

4.3.162. Plant_item_shape to Shape_representation

Each Plant_item_shape is defined using zero, one or many Shape_representation objects. Each Shape_representation defines exactly one Plant_item_shape object.

4.3.163. Plant_process_capability to Changed_plant_process_capability

Each Plant_process_capability is changed by zero, one, or many Changed_plant_process_capability objects. Each Changed_plant_process_capability changes exactly one Plant_process_capability.

4.3.164. Plant_system to Changed_plant_system

Each Plant_system is changed by zero, one, or many Changed_plant_system objects. Each Changed_plant_system changes exactly one Plant_system.

4.3.165. Plant_system to External_classification

Each Plant_system is classified by zero, one or many External_classification objects. Each External_classification classifies zero, one or many Plant_system objects.

4.3.166. Plant_system to Plant_item

Each Plant_system is composed of zero, one or many Plant_item objects. Each Plant_item is part of zero, one or many Plant_system objects.

4.3.167. Plant_system to Plant_system_assembly

Each Plant_system is the super-system in zero, one or many Plant_system_assembly objects. Each Plant_system_assembly has exactly one Plant_system object as the super-system.

Each Plant_system is the sub-system in zero, one or many Plant_system_assembly objects. Each Plant_system_assembly has exactly one Plant_system object as the sub-system.

4.3.168. Point_and_line_representation to Survey_point

Each Point_and_line_representation is defined by zero, one or many Survey_point objects. Each Survey_point defines zero, one or many Point_and_line_representation objects.

4.3.169. Raceway to Raceway_lane

Each Raceway contains zero, one or many Raceway_lane objects. Each Raceway_lane is contained in exactly one Raceway object.

4.3.170. Reference_geometry to Changed_reference_geometry

Each Reference_geometry is changed by zero, one, or many Changed_reference_geometry objects. Each Changed_reference_geometry changes exactly one Reference_geometry.

4.3.171. Reference_geometry to Shape_representation_element

Each Reference_geometry is described by zero, one or many Shape_representation_element objects. Each Shape_representation_element provides description of zero, one or many Reference_geometry objects.

4.3.172. Required_material_description to Changed_required_material_description

Each Required_material_description is changed by zero, one, or many Changed_required_material_description objects. Each Changed_required_material_description changes exactly one Required_material_description.

4.3.173. Required_material_description to Material_specification_selection

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Each Required_material_description is satisfied by zero, one or many Material_specification_selection objects. Each Material_specification_selection satisfies zero, one or many Required_material_description objects.

4.3.174. Route to Node

Each Route consists of one or more Node objects. Each Node is associated with exactly one Route.

4.3.175. Route to Piping_system_line_segment

Each Route is composed of zero, one or many Piping_system_line_segment objects. Each Piping_system_line_segment is a component of zero or one Route object.

4.3.176. Shape_inspection_record to Plant_item_connector

Each Shape_inspection_record has inspected shape defined by zero, one or many Plant_item_connector objects. Each Plant_item_connector defines inspected shape of zero, one or many Shape_inspection_record objects.

4.3.177. Shape_representation to Shape_representation_element_usage

Each Shape_representation is defined by one or more Shape_representation_element_usage objects. Each Shape_representation_element_usage defines exactly one Shape_representation object.

4.3.178. Shape_representation_element to Shape_interference_zone_usage

Each Shape_representation_element defines a volume for zero or one Shape_interference_zone_usage object. Each Shape_interference_zone_usage has a volume defined by exactly one Shape_representation_element object.

4.3.179. Shape_representation_element to Shape_representation_element_usage

Each Shape_representation_element provides a definition for zero or one Shape_representation_element_usage object. Each Shape_representation_element_usage has a definition provided by exactly one Shape_representation_element object.

4.3.180. Shape_representation_element_usage to Interfering_shape_element

Each Shape_representation_element_usage is the intersecting geometry of zero, one or many Interfering_shape_element objects. Each Interfering_shape_element uses as intersecting geometry exactly one Shape_representation_element_usage object.

4.3.181. Site to Building

Each Site has located on it zero, one or many Building objects. Each Building is located on exactly one Site object.

4.3.182. Site to Changed_site

Each Site is changed by zero, one, or many Changed_site objects. Each Changed_site changes exactly one Site.

4.3.183. Site to Location_in_site

Each Site is a reference frame for zero, one or many Location_in_site objects. Each Location_in_site has a reference frame provided by exactly one Site object.

4.3.184. Site to Site_feature

Each Site contains zero, one or many Site_feature objects. Each Site_feature is contained in exactly one Site object.

4.3.185. Site to Site_shape_representation

Each Site has shape defined by zero, one or many Site_shape_representation objects. Each Site_shape_representation defines the shape of exactly one Site object.

4.3.186. Site to Sited_plant

Each Site has located on it one or more Sited_plant objects. Each Sited_plant is located on exactly one Site object.

4.3.187. Site_feature to Changed_site_feature

Each Site_feature is changed by zero, one, or many Changed_site_feature objects. Each Changed_site_feature changes exactly one Site_feature.

4.3.188. Site_shape_representation to Breakline

Each Site_shape_representation is constrained by zero, one or many Breakline objects. Each Breakline constrains zero or one Site_shape_representation object.

4.3.189. Site_shape_representation to Gis_position

Each Site_shape_representation has a global position defined by zero or one Gis_position. Each Gis_position defines the global position for exactly one Site_shape_representation object.

4.3.190. Sited_plant to Changed_sited_plant

Each Sited_plant is changed by zero, one, or many Changed_sited_plant objects. Each Changed_sited_plant changes exactly one Sited_plant.

4.3.191. Stream_design_case to Line_less_piping_system

Each Stream_design_case transports material for zero, one or many Line_less_piping_system objects. Each Line_less_piping_system is associated with zero, one or many Stream_design_case objects.

4.3.192. Stream_design_case to Piping_system_line_segment

Each Stream_design_case defines transport needs for zero, one or many Piping_system_line_segment objects. Each Piping_system_line_segment defines potential material for zero, one or many Stream_design_case objects.

4.3.193. Stream_design_case to Service_operating_case

Each Stream_design_case defines zero, one or many Service_operating_case objects. Each Service_operating_case is defined by exactly one Stream_design_case object.

4.3.194. Stream_design_case to Stream_phase

Each Stream_design_case is composed of one or more Stream_phase objects. Each Stream_phase is defined by exactly one Stream_design_case object.

4.3.195. Sub_plant_relationship to Changed_sub_plant_relationship

Each Sub_plant_relationship is changed by zero, one or many Changed_sub_plant_relationship objects. Each Changed_sub_plant_relationship changes exactly one Sub_plant_relationship.

4.3.196. Supplier to Catalogue_definition

Each Supplier publishes zero, one or many Catalogue_definition objects. Each Catalogue_definition is published by zero or one Supplier object.

4.3.197. Supplier to Supplied_equipment

Each Supplier supplies one or more Supplied_equipment objects. Each Supplied_equipment is supplied by exactly one Supplier object.

4.3.198. Support_constraints to Support_usage

Each Support_constraints constrains the motion in the negative x-direction of zero, one or many Support_usage objects. Each Support_usage has motion in the negative x-direction constrained by zero or one Support_constraints object.

Each Support_constraints constrains the motion in the positive x-direction of zero, one or many Support_usage objects. Each Support_usage has motion in the positive x-direction constrained by zero or one Support_constraints object.

Each `Support_constraints` constrains the motion in the negative y-direction of zero, one or many `Support_usage` objects. Each `Support_usage` has motion in the negative y-direction constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the motion in the positive y-direction of zero, one or many `Support_usage` objects. Each `Support_usage` has motion in the positive y-direction constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the motion in the negative z-direction of zero, one or many `Support_usage` objects. Each `Support_usage` has motion in the negative z-direction constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the motion in the positive z-direction of zero, one or many `Support_usage` objects. Each `Support_usage` has motion in the positive z-direction constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the negative rotation about the x-axis of zero, one or many `Support_usage` objects. Each `Support_usage` has the negative rotation about the x-axis constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the positive rotation about the x-axis of zero, one or many `Support_usage` objects. Each `Support_usage` has the positive rotation about the x-axis constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the negative rotation about the y-axis of zero, one or many `Support_usage` objects. Each `Support_usage` has the negative rotation about the y-axis constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the positive rotation about the y-axis of zero, one or many `Support_usage` objects. Each `Support_usage` has the positive rotation about the y-axis constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the negative rotation about the z-axis of zero, one or many `Support_usage` objects. Each `Support_usage` has the negative rotation about the z-axis constrained by zero or one `Support_constraints` object.

Each `Support_constraints` constrains the positive rotation about the z-axis of zero, one or many `Support_usage` objects. Each `Support_usage` has the positive rotation about the z-axis constrained by zero or one `Support_constraints` object.

4.3.199. `Support_usage_connection` to `Plant_item_connection_occurrence`

Each `Support_usage_connection` is detailed by zero, one or many.

`Plant_item_connection_occurrence` objects. Each `Plant_item_connection_occurrence` gives the details for zero or one `Support_usage_connection` object.